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VOLUME XXXIX NOVEMBER, 1924 NUMBER 5

Surgery, Gynecology and Obstetrics

WITH

International Abstract of Surgery

Official Journal of the American College of Surgeons

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PUBLISHERS FOR GREAT BRITAIN: Bailliere, Tindall & Cox, 8 Henrietta St., Covent Garden, London, W. C., England

Published Monthly. Annual Subscription: United States and Canada, $12.00; Foreign, $14.00.
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Entered as second-class matter May 22, 1913, at the postoffice at Chicago, Ill., under the Act of Congress, March 3, 1879.

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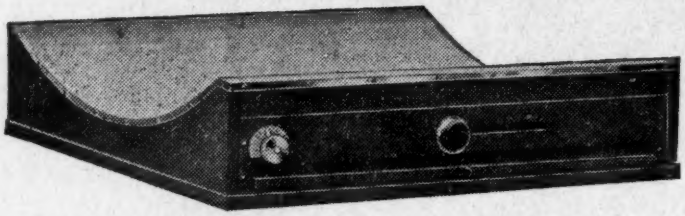

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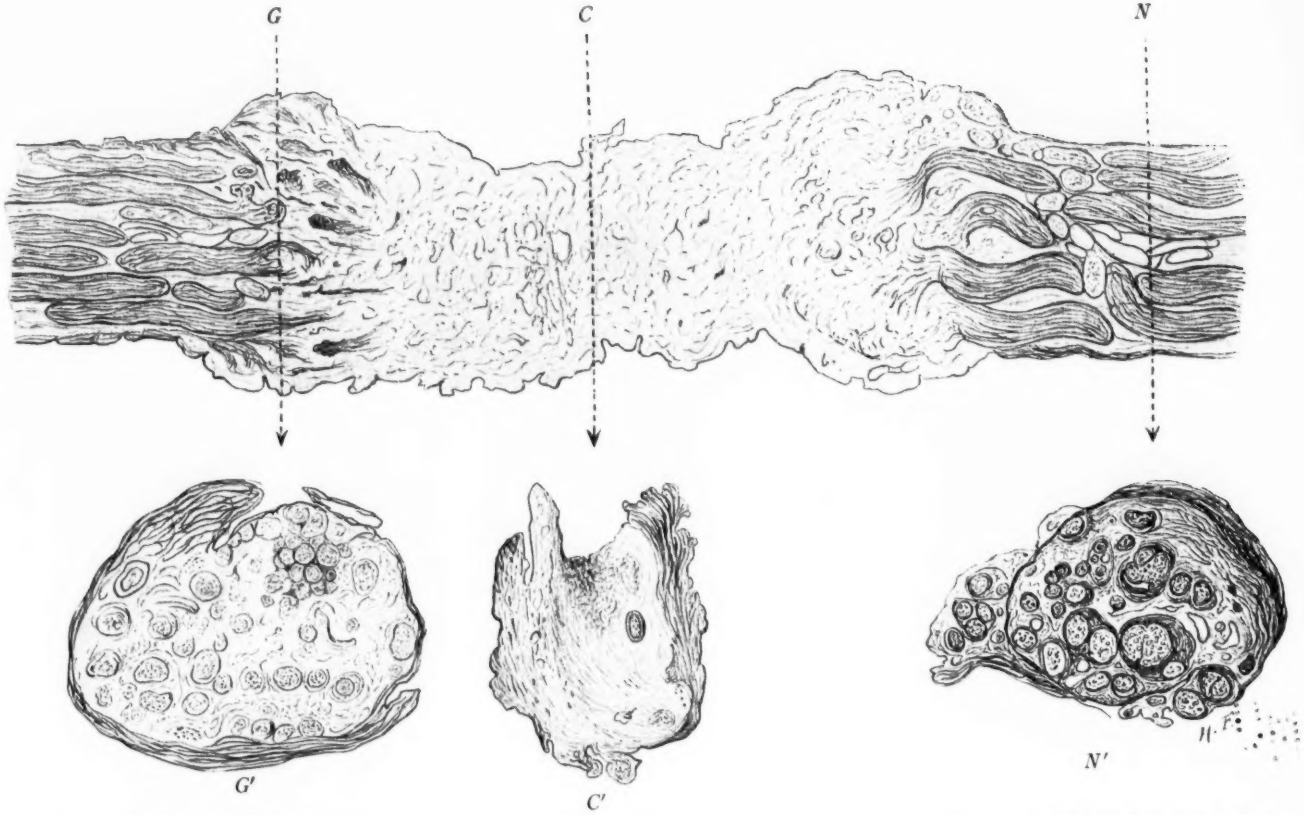

Fig. A. A longitudinal section of the resected sciatic nerve with a central neuroma, *N*. *G*, Peripheral glioma and. *C*. interposed cicatricial tissue. *G'*, *C'*, and *N'* are transverse sections through the same regions.

A Contribution to the Study of the Surgical Repair of **Peripheral Nerves.**—*Henry Delagénière*

SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME XXXIX NOVEMBER, 1924 NUMBER 5

A CONTRIBUTION TO THE STUDY OF THE SURGICAL REPAIR OF PERIPHERAL NERVES

BASED ON THREE HUNDRED AND SEVENTY-FIVE CASES[1]

BY HENRI DELAGÉNIÈRE, LE MANS, FRANCE

BEFORE the war I had the opportunity to perform a certain number of nerve sutures immediately following injury. Usually these were cases of complete section of the nerve produced either by the end of bone in certain fractures, by gunshot wound, or by a knife. In every case immediate operation was necessary because of the seriousness of the wound, and in every case the suture which was done after freshening the nerve ends resulted in a functional cure. On the other hand I have performed resection of the cut ends for an old section of the radial nerve, following which I did an end-to-end suture. A complete cure with a return of entire function was obtained at the end of 10 months.

It became evident during the war that if wounds of the peripheral nerves were to be treated surgically with success, certain rules would have to be established and a proper technique based upon the results that had been obtained would have to be standardized. Following the wounded men after operation was a serious difficulty.

With the hope of securing success and as chief surgeon of the Fourth Army Corps, I obtained the authority to group all these cases in a hospital near Le Mans. All the wounded who had been operated upon for lesions of the peripheral nerves in my sector were assigned during the period of convalescence to Dr. Tinel, a famous neurologist and chief of the neurologic service of the Fourth Corps. All the wounded were examined before operation at the neurological center. They were operated upon by myself or by my colleagues, who were doing research work with me at the time. After the wound had entirely healed, they were evacuated to a special hospital and were visited by Dr. Tinel every 15 days until their complete cure.

We were able to follow 375 wounded men whose cases were divided as follows:

Simple neurolysis	113
Resections and sutures	236
Nerve grafts	9
Resection and immediate suture for causalgia	17
	375

The 113 neurolyses did not give good results except in those cases in which there was a simple compression without a demonstrable lesion of the nerve. In these recovery was rapid and complete. In the other cases which were by far the greater number, operation did not give as favorable results as did non-intervention which was advised by Tinel. It was nearly always found that the nerve was compressed or strangled, presenting an interstitial lesion (neuroma or cheloid) which pre-

[1]This paper was translated and edited, for the author, by Philip Lewin, M.D., assistant professor of orthopedic surgery, Northwestern University Medical School, Chicago.

vented the reconstruction or the re-establishment of its functions.

The 236 nerve resections followed by suture can be divided into 142 sutures performed correctly, that is to say they conformed to the anatomical and physiological requirements of reconstruction of the nerves, and 94 sutures performed incorrectly or by employing poor technique.

These two figures have been corrected since I published my former figures, in which 39 observations classed in the beginning among the correct sutures, were later classified among the incorrect sutures, because the entire central end of the nerve was a neuroma. At the beginning I thought that resection would not have to be performed farther back than the point where the first nerve fasciculi appeared. This was an error in technique that we have since recognized.

The 142 correct sutures have resulted in 122 complete successes (85.9 per cent), 16 partial successes, and 4 failures.

On the other hand the 94 incorrect sutures have given only 6 complete successes, 37 partial successes, and 51 failures (54.2 per cent).

In order to explain the poor results of the incorrect sutures it will be sufficient to enumerate the methods employed.

Eight sutures where nerve ends were far apart with the interposition of strands of catgut..... 8 failures
Eight sutures after division and reversing of the nerve..... 8 failures
Three anastomoses of the 2 living ends of the nerve with an adjoining nerve..... 3 failures
Six miscellaneous..... 6 failures
Six conical resections of the central end and two partial successes.. 4 failures
Sixty-five in which the resections of 1 or both ends of the nerve were insufficient.....22 failures

There were but 6 good results and 35 partial successes.

I will now present two tables showing the results obtained in the individual nerves in which the sutures were performed correctly and in which the sutures were performed incorrectly.

TABLE I.—SUTURES CORRECTLY PERFORMED

NERVE	No. of cases	Complete success	Partial success	Failures
Radial	47	37 (82.9%)	7 (14.89%)	3 (6.34%)
Ulnar	23	19 (82.6%)	3 (13.04%)	1 (4.34%)
Median	15	13 (86.66%)	2 (13.33%)	0
Musculo-cutaneous	5	5 (100%)	0	0
Brachial-plexus	2	1 (50%)	1 (50%)	0
Sciatic nerve trunk	25	23 (92%)	2 (8%)	0
External popliteal	15	14 (93.33%)	1 (6.66%)	0
Internal popliteal	4	4 (100%)	0	0
Posterior tibial	6	6 (100%)	0	0
	142	122 (85.91%)	16 (11.26%	4 (2.81%)

TABLE II.—SUTURES INCORRECTLY PERFORMED

NERVE	No. of cases	Complete success	Partial success	Failures
Radial	28	2 (7.14%)	5 (17.81%)	21 (75%)
Ulnar	23	2 (8.69%)	9 (39.13%)	12 (52.1%)
Median	14	2 (14.28%)	6 (42.85%)	6 (42.9%)
Sciatic nerve trunk	13	0	8 (61.53%)	5 (38.5%)
External popliteal	8	0	5 (62.5%)	3 (37.5%)
Internal popliteal	3	0	1 (33.33%)	2 (66.66%)
Posterior tibial	5		3 (60%)	2 (40%)
	94	6 (6.38%)	37 (39.36%)	51(54.25%)

Concerning the results of the wounded operated upon during the years of 1915 and 1916 and during the early months of 1917, all the observations were studied by Dr. Tinel and were given in October, 1917, in a report to the military authorities. At that time the details of the technique had not yet been worked out. It is probable that the results of our operations would have been more favorable, but it was impossible for me to complete my investigations because of the military requirements in the Army Corps, which made it necessary to give up those special hospitals which had been at my disposition.

Meanwhile I was able to make important observations which would aid in obtaining good results in nerve sutures. I shall enumerate them as follows:

1. The earlier the suture is performed the more rapid is the regeneration. The correctness of this statement is proved in the case of

causalgia treated by resection followed by immediate suture and in the case of suture made at the time of injury.

2. In the case of delayed suture, the regeneration is simply delayed, but eventually it should be just as complete. We have had complete and excellent results in the case of a suture performed as late as 28 months after the injury. No matter how old the wound, it is worth the trial of operation.

3. The regeneration appeared to be much quicker when there was complete physiological interruption but no separation of the ends of the nerve. With the separation of the two ends, regeneration is less rapid just as in the case where the peripheral segment was very markedly disorganized.

4. The radial, musculocutaneous, and external popliteal nerves regenerate most quickly. The internal popliteal, the ulnar, and the median regenerate with greater difficulty. This is due to the fact that there is a greater number of sensory fibers which go to make up the nerve and to the danger of aberration of the nerve fibers in the new formation. The motor fibers grow down into the open sheaths of the sensory fibers, and vice versa. This produces a type of useless regeneration (Tinel).

The general practical considerations and the operative results afford an important contribution to the elaboration of good operative technique but before establishing this technique it seems important to recall to mind a few words about the degeneration and regeneration of nerves.[1]

All the nerve fibers sectioned undergo a centrifugal degeneration at the peripheral end (wallerian degeneration); in fact one sees the axis cylinders become fibrillated and fragmented, or completely disappear. The myelin sheath becomes irregular and sinuous, and its segments finally disappear. During this time the sheath of Schwann proliferates and forms an empty sheath in place of the nerve fibers. The central ends undergo a like change with moderate retrograde degeneration, which ascends. This ascending retrograde degeneration is quickly limited, and ceases as soon as the regeneraton begins.

[1] See Tinel, "Nerve Wounds," published by Masson, Paris.

This affects the penetration and descent of the axis cylinders from the central end in the open sheath of the peripheral segment. The axis cylinders are attracted by the sheath. This phenomenon is known in physiology by the name of neurotropism. In proportion to the progress of the axis cylinders there is a new myelin sheath produced. The axis cylinders progress about 1 to 2 millimeters a day, depending upon the age of the nerve wound and the age of the wounded man.

This explains the very long time required for the nerve to regenerate, and likewise when the anatomical reconstruction has occurred it requires still more time for the nerve to recover its physiological function.

If in the case of a nerve section, the two ends are in contact or are separated by a very short space, the regeneration can occur normally, but if the two ends are too far separated, or if there exists between the two ends a space that cannot be bridged, the regeneration cannot occur. From the central end the axis cylinders proliferate, but these cannot be attracted by the sheath, and therefore curl up upon themselves, and at the central end there is formed a small tumor called a cheloid or neuroma. It is this which prevents regeneration of the nerve. The peripheral end of the nerve also presents a small tumor mass or false neuroma, which in reality is a glioma (Nageotte). This is made up of the excessive proliferation of the cells from the sheath of Schwann, and completely surrounds and isolates the tubules at the peripheral end.

If the nerve itself has an injury sufficiently severe to cause the physiological section of the nerve, without solution of the continuity of the sheath, there results instead of regeneration, the formation of a tumor, which is found at the site or close to the region traumatized. This also results in the formation of a neuroma (see Fig. A, *N* and *G*) at the level of the central end, and a glioma at the level of the peripheral end. The two tumors are found close to each other sometimes without transition, and on the contrary sometimes separated (see Fig. A-*C*) by a tract of fibrous tissue of varying length, composed of neighboring and nerve tissue, and by the retraction of the traumatized fibers of the sheath of Schwann.

At the side of this neuroglioma one can find a pseudoneuroma resulting from the interstitial hæmorrhage around the thickness of the nerve, which becomes fusiform and elongated. If the lesion affects only a small portion of the nerve, the phenomena of regeneration will be the same for each bundle injured.

The neuroma occupies only one portion of the thickness of the nerve, but it always behaves in the same manner, and hinders the axis cylinders from growing out around the tubules necessary for regeneration.

I shall pass now to review the principal lesions which can affect the peripheral nerves. These lesions are not always apparent. It should be remembered as a fact that a nerve can be sectioned from the physiological standpoint, in which case there will be no visible section. We must also bear in mind that a recent or fresh nerve lesion does not present the same picture as does an old lesion. From this point of view it will be useful to study the nerves, (1) at the time of injury, and (2) sometime after the injury.

A. At the time of the injury. The nerve perhaps is sectioned by a sharp instrument or contused and crushed, with or without separation of the two ends, by a blunt instrument, such as a piece of shell. In the first instance the lesion is clean cut, and is less serious than in the second case. It is more difficult to appreciate the extent and the gravity of the latter type of a lesion, which always extends beyond the appreciable limits of the view. It is at the outer borders of the visible lesion where the neuroma and cicatricial tissue which prevent the regeneration of the nerve later, forms (Fig. B).

With this reservation made, when one examines a wounded nerve in a fresh wound, the nerve is completely sectioned, the continuity is conserved, or it has been torn from one of its ends. If it is completely sectioned, the central end usually retracts (see Fig. B, *1* and *3*), and the cut nerve bundles can be seen. These become more clearly visible when the nerve end is compressed between the ends of the fingers. The sheath of Schwann may be slightly retracted and form about a millimeter from the section a little circular pad or cushion more or less regular which usually is easily distinguishable. The peripheral end is usually sectioned more cleanly. On slight pressure between two fingers one cannot make the nerve fibers stand out, but one does show the sheath. The sheath of Schwann is equally more difficult to distinguish. If the nerve has conserved its continuity one is able to observe all the possible lesions which one is able to classify into the following types:

1. *Simple contusion.* The nerve is hard in its contused portion, and gives one the sensation of palpating wood. One is able also to observe a slight bloody infiltration at the level of the contusion (see Fig. B, *2*).

2. *An interstitial hæmatoma* in the nerve which presents a demonstrable nodule to the view and to palpation, and which sometimes reaches the size of a small hazel nut. This hæmatoma has a violet or brownish color, preventing one from seeing the exact condition of the nerve tissue. Sometimes it hides a complete section of the nerve where the two ends are held in contact by the sheath of Schwann which remains intact. One can never be too careful in deciding whether the nerve should be treated by resection and suture or be allowed to take care of itself.

3. *A lateral indentation* (see Fig. B, *3*). The little wound forms in these cases a sort of notch in the border of the nerve. The borders of the notch are crushed, not smooth, and do not always permit you to observe all parts of the nerves and therefore to treat them properly. Moreover, I have observed that partial resection of the nerves, with certain exceptions, do not give as good results as total resection.

4. *Perforation of the nerve* (see Fig. B, *4*). The nerve should be examined with the greatest care because very often a perforation will be mistaken for a simple contusion, and when the exact lesion is determined it is necessary to treat it by resection and suture for the reason that the lesion probably involves the nerve tissue. Finally, if the nerve is torn at one of its ends as we sometimes see in the very severe large wounds, one must preserve it carefully and look further for the other end, which was left in the wound, and perform a suture. Sometimes, the stump of the nerve is much elongated, sometimes it has

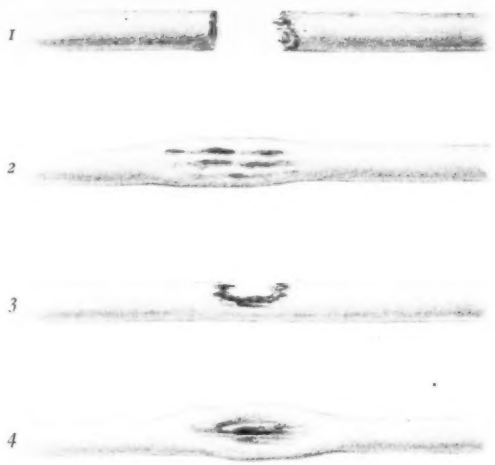

Fig. B. Semischematic drawing illustrating the recent lesions observed in the peripheral nerve. *1*, Complete section; *2*, contusion with slight bloody extravasation; *3*, partial lateral section; and *4*, perforation.

been pulled out and crushed outside of the wound. This exterior portion may be soiled and even infected, but it must not be sacrificed in any case. It should be carefully cleansed with warm salt solution and replaced and sutured if it is possible. The difficulty in this case is in finding the end which remains in the tissue. Very often it is necessary to explore many centimeters lower than is indicated by the segment of the nerve which is torn.

B. After the wound is cicatrized one must wait a sufficiently long time to be certain that the wounded nerve has exhausted all its resources and that nature will not regenerate it. At least 4 months is necessary to be able to establish a probable prognosis on the repair of the function of the nerve If at the end of that period there are no clinical signs of return of function, such as tingling, on striking along the course of the nerve, or the reappearance of the contractility of certain muscles which were found paralyzed on the first examination, it is necessary to consider surgical intervention. If the nerve has been injured and if the phenomena which indicate its reorganization are not in evidence it is necessary to perform a complete section of the neuroma

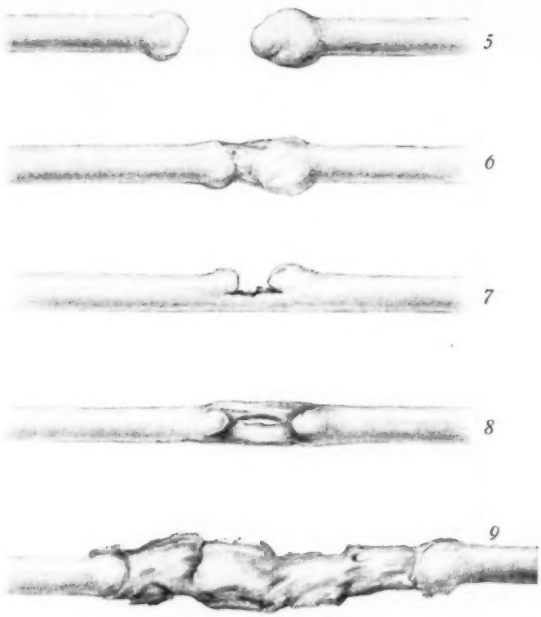

Fig. C. Semischematic drawing illustrating the principal chronic lesions of the peripheral nerves. *5*, Complete section with the central neuroma and peripheral glioma; *6*, same lesions with a small zone of interposed cicatricial tissue; *7*, lateral notch with small neuroma and small lateral glioma; *8*, perforation with central neuroma and central glioma; *9*, large lesion with long zone of cicatricial tissue between the neuroma and glioma.

on the central end, and the glioma on the peripheral end (see Fig. C, *5*). Often between the two ends one will find remaining a mass of fibrous tissue equally impermeable to the axis cylinders. Many times these neuromata reach the size of a hazel nut, and in certain cases it is possible by palpation to determine that they involve the skin. If the nerve was not sectioned one can find, as we have already seen, either a central nodule (see Fig. C, *6*) made up of the elements of the neuroma and a glioma or a lateral nodule if the nerve was sectioned only in part of its diameter (see Fig. C, *7*). In the latter case clinical examination will almost always entirely reveal the anomalies in the function of the nerve. Perhaps it had not been completely paralyzed but was simply functionless and was accom-

panied by sensory disturbances following the wound of the nerve.

It should also be mentioned that the lesions of the nerve following crushing injuries of the bones are often equally interesting; the nerve is caught in a covering of fibrous cicatricial tissue, and even in the bony tissue. The lesions which are usually found in these cases are spoken of as *compression of the nerve* and explain the frequent failure in the simple liberation. If the compression has been exerted on a small portion of the nerve it will result in the formation of a neuroma above it, and a glioma below it (see Fig. C, *9*). The pathology produced in compression of the nerve is similar to that in a lesion of the nerve which is more severe. Practically always when one disengages the nerve that was included in a bony callus, one has only liberated a nerve which has been physiologically sectioned and one which can recover its function only after resection and suture of the two ends of the nerve. In the favorable cases one finds simply a nerve compressed and not destroyed. The simple compression may be produced by a foreign body which compresses the nerve against the bone, or by a sheath of cicatricial tissue which envelops the nerve without destroying it. It is possible in certain cases of simple compression that the simple liberation may be followed by a very rapid cure. Usually it is necessary to wait many weeks to establish the return of movements, and it is often useful to hasten the convalescence by electric treatment. Lastly, it is of great importance to recognize a simple compression of a nerve from a physiologic impairment due to trauma. There are certain factors which aid in those cases in which the diagnosis is difficult.

The following points help in the diagnosis of the difficult cases of simple compression:

1. Absence of all nodules in the thickness of the nerve when it is carefully palpated.

2. The persistence of the peripheral circulation visible on the surface of the nerve.

3. The preservation of the external form of the nerve.

In spite of this examination one may be in doubt, and should without hesitation perform a resection and suture if one does not want to expose himself to a failure which is nearly certain, as I have stated in my statistics. I have completely abandoned the electrical examination of the denuded nerve trunk, because I have been led into error in many cases, because a few of the nerve fibers were sufficient for a regeneration and this was not realized.

The technique will be easy to deduce from the general considerations which have preceded. I presented it at the French Congress of Surgeons in 1918, and have not modified the details since then. I shall consider it as follows:

OPERATION AT THE TIME OF INJURY

It is of great importance to explore the wounded nerve as soon as possible after the wound has been received. This is particularly true if for one reason or another the wound itself needs an exploration and incision of the wounded parts. In these cases the nerve suture will be complicated with little intervention, and you will render the wounded man a very great service. I have thus performed a certain number of very early interventions and all of these were followed by complete cure with the return of motor and sensory function of the nerves, in a lapse of time which was much less than in those cases where the operation was done secondarily. Unfortunately, because of the scattering of a certain number of wounded, it is not possible to give the results with great accuracy. However, when you consider those which have been followed, and the results of the primary sutures, one must admit that early suture presented the following advantages:

a. Ease of investigation and study of the lesion, and the subsequent resection made under the best conditions.

b. A minimum resection because the nerve trunk has not yet had time to invaginate by progressive sclerosis.

c. The maximum mobility and elasticity of the nerve trunk which will permit approximation, or if this is impossible to prepare the nerve for a secondary operation.

d. Certain gain of 3 or 4 months in the course of the treatment since it is not wise when the operation has been deferred to intervene until 3 or 4 months' observation of the wounded has been made.

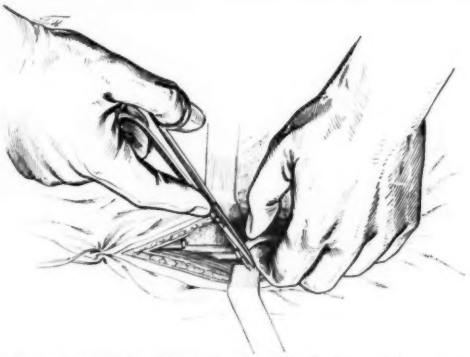

Fig. D. Drawing illustrating method of procedure and the recutting of the nerve ends with scissors.

e. Finally, assurance that you will not endanger the result if the intervention is not followed by success. On the contrary, the first intervention and suture of the nerve in a good position provides impediment to retraction, so that the secondary operation may be executed with excellent technique. The operation includes the exposure of the nerve, the surgical treatment of the nerve, and the closure of the wound.

Exposure of the nerve. In the case of a wound by a bullet, by shrapnel, or in case of simple division by a bayonet wound or a crushing wound of the extremity with comminuted fractures, one must first treat the wound itself. First, it is necessary to make an incision and excise the contused and infected parts, so that the nerve will be accessible in the wound by a secondary incision which will not endanger the result. If it is a question, on the contrary, of a section by a bullet wound which is non-infected, and for which the same intervention is not believed necessary; or if all the evidence of any particular wound indicates that it is not necessary to operate as an emergency one should take all the time necessary to examine the case completely. Under such circumstances an operation should not be done until one is certain that a complete section has occurred and that there will be no danger of a secondary infection.

The surgical treatment of the nerve. The nerve must be studied to see whether the lesion is a complete section, incomplete section, simple contusion, or hæmatoma, i.e., all the lesions

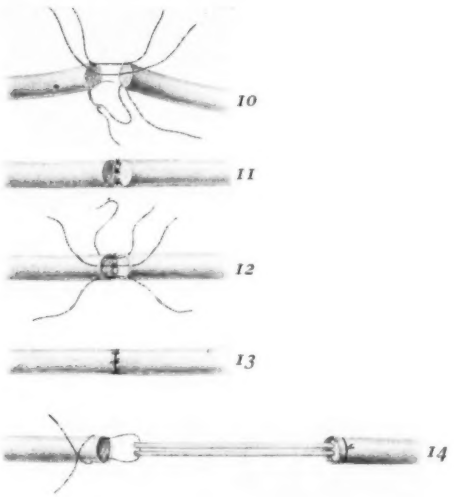

Fig. E. Semischematic drawing illustrating the various steps in the suture. *10*, Placing the three sutures posteriorly to hold the neurilemma (the needle goes from without inward); *11*, the three posterior sutures are tied; *12*, placing the three anterior sutures; *13*, the suture is complete; *14*, manner of suture of double grafts of the musculo-cutaneous nerve. It shows how the suture goes through the double graft, then through the neurilemma and is finally tied on the outside of the nerve. It is tied just tightly enough to approximate the two ends of the graft and the cut section of the nerve.

which we have described. The difficult point is to recognize the gravity of the damage, and from what I have already advanced concerning the doubt of a possible reconstruction of the injured nerve, one must not hesitate to intervene and perform a suture when one has ascertained that there is present a complete section or an incomplete section of the nerve, a perforation, a notch, a severe contusion, or a diffuse hæmatoma. Given such lesions one must perform a resection of the injured portion. This resection should be done upon the two liberated ends of the nerve or beginning in the middle of the lesion one must progressively examine the nerve until it shows a healthy appearance. The bloody extravasation will sometimes be a guide to find the limits of the lesion, not that the resection must extend to the extreme limits of the bloody infiltration, but it must be brought near these extreme limits, because the nerve tissue of the section must not be gorged with blood.

The resection must be done by successive cuts with a very sharp scissors or knife. Some have stated that section with a knife is preferable, because there is less traumatism and it is neater. I have never found for my part any difference between section with the bistoury and section with scissors. Since they are more rapid and simple I have had recourse to the scissors and have never noted any difference in the end-results. At the time of the injury, the resection will be always very markedly limited. One or 2 centimeters will be sufficient in the great majority of cases and we always try to make as limited a resection as is possible and still obtain an apposition under good conditions. It is especially in the case of a large crushing wound of the bone with nerve lesions that early intervention is necessary. For the moment the wound of the nerve is not often very important although it usually complicates the lesions because of enclosure in the bony callus with resulting compression. Under these conditions the nerve repair far from being made easy is hampered by the penetration of the elements of the callus from the fracture into the nerve tissue. The latter allows therefore the invasion by a fibrous degeneration ending in a definite sclerosis which considerably augments the extent of the primary lesion. It necessitates a nerve resection much more extensive, a second operation, and often makes the apposition of the two ends more difficult, and sometimes impossible.

LATE OPERATION

It is usually at the end of the fourth month after injury that this operation will perhaps be tried. When the primary wound is completely healed, and there is no more doubt that the slightest infection exists, one is also able to assure himself that the work of regeneration during this lapse of time has not been effective.

Exposure of the nerves. In certain cases one may wait upon the cicatrization of the wound and the debridement before attacking the nerve. It will be of advantage to excise the cicatricial portion, and to liberate the skin completely. Oftentimes one is obliged to search for the nerve by a classical incision without taking into consideration the primary wound. One takes for the middle of the incision the presumed place of the nerve lesion, and incises above and below along a tract of 3 to 4 centimeters. It is necessary, therefore, to use an incision on the average of 8 or 10 centimeters to expose the nerve. This incision can be lengthened if it is necessary. When the skin is incised, the muscles should be retracted as much as possible but not cut, in order to preserve intact as far as possible their aponeurotic covering. One is able to approach the wound between the muscles and to find the axis cylinders in their descent. One is able also to study the extent of the lesion and to re-examine the nerve above and below. One should wait before exposing the neuroma until its exact relation to the nerve has been recognized. It is within the healthy portions of the nerve above and below the lesion that one must carefully study the extent of the lesion. Before the nerve is completely liberated one should mark the free surface above and below the lesion. The situation of the nutrient arterioles of the nerve should be taken into consideration in making such an identifying mark. In certain cases one is able to place a small thread in the neurilemma of the free surface and at a corresponding symmetrical place on the other end of the nerve. After the marking one frees the nerve carefully above and below. The apposition of the two ends is delayed until the upper and lower portions of the isolated nerve are again examined. This is done to be sure that thickening of fibrous tissue does not exist.

One generally sees the nerve disappear in an indurated and cicatricial mass of tissue; sometimes into the callus of a fracture. One should determine whether or not the nerve is simply compressed by the injured tissues, because in this case a simple dissection will be sufficient for the liberation. One will recall that the nerve trunk may be compressed in its thickened and fibrous sheath, and when this sheath is gently incised one may observe the nerve actually free itself. One should proceed in the same manner if the nerve is engaged in a bony callus by using a gouge and mallet. Thus disengaged and isolated the nerve trunk should be inspected, the neuroma and glioma should

be examined. One should study that portion of the nerve which is to be resected and fix the points at which the section of the central and peripheral ends are to be made. If the lesion appears insignificant, and if it is certain that the nerve is not compressed, one may be satisfied with performing a simple liberation. However, if there is any doubt as to whether any small portion of the nerve is compressed, stretched, or lacerated, I believe that it is preferable to perform a resection-suture. The more one studies the problem of regeneration experience will show that such a procedure gives better and quicker results. When resection is decided upon one must bear in mind the possibilities of reconstruction of the sectioned nerve. It is necessary to place the member in flexion and exert traction on the two liberated extremities of the nerve so that the two ends can be brought into contact.

Major surgical problems. In the case of a simple nerve liberation, such a procedure constitutes the entire operation. If resection is required, it must be remembered that the main purpose is to bring together both extremities and then to suture them. By preference the section is done with scissors (Fig. D) since they give a neat cut and it is easy to recognize the bundles and tubules of nerve. The section must be done in the very middle portion of the lesion, that is through the fibrous tissue interposed between both ends. The proximal part of the neuroma is severed with successive cuttings made near each other; these sections should be discontinued only when the nerve tissue is exposed to view. A suture made before this point is reached would fail; on the other hand the greatest latitude must be conserved in order to section the peripheral end. On this side section until the nerve tubules start to appear. If the nerve is pressed between the tips of the fingers they become quickly visible. Now, if the extremities are apposed easily, if one wishes, all of the neuroma of the central part may be resected. In this case all the conditions required to obtain a good result are obtained, and so far this should be considered as a certainty.

In the event that it is not possible to approximate both ends, the operation is done in two stages. The extremities of the nerve may be stretched as far as is possible and after resecting as much of the fibrous tissue as is possible, sutures may be made into the scar tissue of either end. Such a suture may obtain a lengthening of 3 to 4 centimeters. This lengthening is obtained by means of continuous traction on both ends. In the second stage, resection may be made under favorable conditions. The maximum of lengthening which may be obtained by this means is about 4 centimeters. After the first stage it may be determined whether it will be necessary to graft in order to suture. In this case the resection of both ends is done at once.

Suture of the two nerve ends. I shall now describe the final suture which is done in one or two stages, and the grafting.

Suture (Fig. E). It must be done in a simple manner using very thin straight or small curved intestinal needles. Use very fine silk. In making the suture avoid transfixing the nerve, the stitches are put through the nerve sheath without touching the nerve itself. The main effect of this suture is to approximate the ends and at the same time to prevent any overlapping. As this suture is made to hold in slight tension, catgut should never be used because it may absorb before the fusion of nerve elements occurs. Physiologists have shown that the union of a sutured nerve occurs soon, but is not firm until after 4 weeks. After this period a sutured nerve cannot be torn off by the normal motions of limbs, even if it was sutured in flexion, and there is no danger in putting the limb through gradual progressive movements of extension.

In order that the different bundles correspond with each other at both ends, it is best to establish a landmark. Thus one stitch is made in the posterior middle part and the needle perforates the neurilemma about 2 millimeters deep. Two more stitches are inserted so that the first will be in the median line. Then the first one should be tied (Fig. E, *10*).

Then the nerve is allowed to assume its normal position, so that both ends come together (Fig. E, *11*). The suture may be completed with two or three more interrupted sutures (Fig. E, *12*). Anteriorly one can approximate the neurilemma without allowing

nerve fibers to project between the sutures. Posteriorly, one must exercise more care to obtain a similar result (Fig. E, *13*), and it is sometimes necessary to place one or two supplementary sutures. While it is not absolutely necessary to obtain complete closure of the neurilemma sheath, such a condition is ideal. The contact of the ends is the vital factor not only at the time of operation but during the period of regeneration. To avoid the spreading of the two ends it is useful to maintain some kind of support.

If the nerve resection has been rather large and it is impossible to approximate the ends, flexion of the forearm or leg may help to obtain apposition. Our own observations give the following as the maximum of lengthening which may be obtained:

Radial in the arm: 6 centimeters.

Ulnar in the arm: 2 centimeters.

Ulnar in the elbow carrying it towards the external condyle with the elbow flexed: 5 centimeters.

Ulnar at the middle inferior part of forearm: 3 centimeters.

Median nerve: 2 to 5 centimeters.

Sciatic trunk at various levels: 8 to 10 centimeters.

External popliteal: 4 centimeters.

Tibialis posterior at various levels: 2 to 4 centimeters.

In certain cases to gain contact the following methods are indicated:

1. If the nerve lesion in the arm or forearm is accompanied by a fracture, a bone resection of three or four centimeters will lengthen the nerve to the same amount. I have used this method on several occasions and I never hesitate to perform a bone resection of both bones of the forearm or of the humerus in order to obtain a perfect contact for the three main nerves of the upper limb even in the absence of a fracture. There is no comparison between an arm shortened 4 to 5 centimeters with excellent innervation and one without nerve supply but of normal length.

2. Under certain conditions, nerve sutures may be done in two stages. Resections of two or four centimeters in most of the nerves, and 5 centimeters in the sciatic prevents primary union by suturing. Therefore, if in the course of the liberation it appears necessary to make a large resection and it is probable that the ends cannot be approximated, the field must be prepared in this way: the fibrous tissue must be removed extensively and more so in the central than in the distal end. In doing that the axis cylinders have the chance to be free and to pass through the tubes (if there are any) belonging to the distal extremity and can produce regeneration of the nerve thus avoiding further intervention. At the second operation the suture may be performed easier and the second resection is done through a plain neuroma of the central end. Successive and small sections should be made on the peripheral end until fresh nerve fibers are found. Suture is then done in the way described above.

As historical facts I mention the following methods:

1. Distant suture by means of catgut strands extended as a bridge between the ends. It was believed that the nerve tubules could thus pass to the peripheral end.

2. Tubular suture of von Lair. It was expected that the axis cylinders would go through a rubber tube connecting both ends.

3. The neuroplastic methods. These were illogical. No good results have followed these procedures.

GRAFTING

The nerve grafts are the last surgical resource to repair large losses of nerve tissue. It is the only logical method. There are three types of graft:

1. Heteroplastic; 2. Homoplastic; 3. Autoplastic.

The heteroplastic graft utilizes nerve tissue from a dead human being. Nageotte and Sencert were its authors. Physiologic experiments gave satisfactory results and Sencert (1918) performed this operation upon eight persons, but at this time none have completely recovered. It has been too short a time to expect marked improvement. Tinel, Meyer, Jacquemin, and myself have used it; all of us noticed the beginning of regeneration by the appearance of the sensation of tingling in the distal extremity, but after five or six months all signs of progressive regeneration were gone. I think it possible to obtain com-

plete success in a short graft but I doubt its value in grafts longer than 12 centimeters.

The homoplastic graft consists in transplanting a piece of nerve from a wounded person, as for instance in an amputation. The pieces of nerves may be kept in a refrigerator. I have used this method twice, but was unsuccessful in both instances. In one case the wound became infected, the other patient was lost sight of.

I have used the autoplastic graft with some results. I took portions of the musculo-cutaneous nerve of the leg. I have had a complete recovery with the radial nerve and two very fair results with the ulnar. How can we explain these results in the case of the ulnar which is a mixed nerve? Whatever the explanation may be it has been proved true that by means of grafting fragments of the musculocutaneous nerve of the leg as long as 13 centimeters, the peripheral nerve has recovered its function.

1. *Technique.* Dissect the musculo-cutaneous nerve in a length double that needed in the graft.

2. Divide the nerve in two pieces of equal length (Fig. E, *14*).

3. Transfix these two ribbons with fine silk.

4. Suture the graft in such a manner that its ends fit like parts of the nerve.

5. Don't tie the sutures too tightly.

It is supposed that the axis cylinders pass through the graft and reach the peripheral end. It is somewhat difficult to obtain good results.

OPERATIONS TO RELIEVE CAUSALGIA

The surgical treatment of this condition by the section of the affected nerve and its succeeding suture is the logical issue of what I have said about nerve sutures. Single liberations of the painful nerve or large incisions of its neurilemma have not given satisfactory results. I have been using periarterial sympathectomy, devised by Leriche, with some temporary improvement. I therefore decided to cut the nerve about the painful region and suture it. With this procedure I have always obtained good results.

Technique. The nerve is dissected free through a classical incision made over the traumatized region. The nerve is carefully examined for microscopic changes. Sometimes there is only a firmness of the nerve and its neurilemma appears congested. Above these lesions, in a proper place the section is performed, and both ends are sutured in the way described above. The patient experiences great relief at once (when the section has been performed in the proper place).

The purpose in sectioning the nerve is to give it complete rest so that it may be cured of its inflammation (neuritis). This requires a long time (one year at least) but in spite of this delay the causalgia is relieved when the regeneration occurs. It may be that the patient may need a second operation as in the case of a patient of mine in whom the ulnar causalgia disappeared soon, but recurred in four months. After the second operation the recovery was complete.

THE TREATMENT OF BRAIN ABSCESS BY UNROOFING AND TEMPORARY HERNIATION OF ABSCESS CAVITY WITH THE AVOIDANCE OF USUAL DRAINAGE METHODS[1]

With Notes on the Management of Hernia Cerebri in General

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ALL operative procedures heretofore described in the treatment of brain abscess have been based upon three well recognized principles:

1. The drainage of the abscess cavity,
2. Prevention of extension of meningeal infection,
3. Prevention of hernia cerebri.

Various authors have described different methods of exposures for the purpose of drainage of an abscess cavity. Adson (1) has advised an osteoplastic flap with drainage of the abscess cavity, the drain being brought out through a separate trephine opening made through the osteoplastic flap. Eagleton (3) has advised the osteoplastic flap for abscesses located in the middle fossa and frontal region. Dowman (2) and Kerr (4) have advocated exploration for and drainage of the abscess cavity through a small trephine opening in the skull. However, in each of the procedures advocated, without regard to the type of exposure, the intention of the surgeon has been to locate and drain the abscess cavity by means of some kind of drainage material and to prevent herniation of the brain.

In the rather large number of fatal cases, death usually occurred from rupture of the abscess cavity into the ventricular system, meningitis, or compression of the brain, or death may have resulted from any two or all of these causes.

DIFFICULTIES AND DANGERS OF USUAL DRAINAGE METHODS

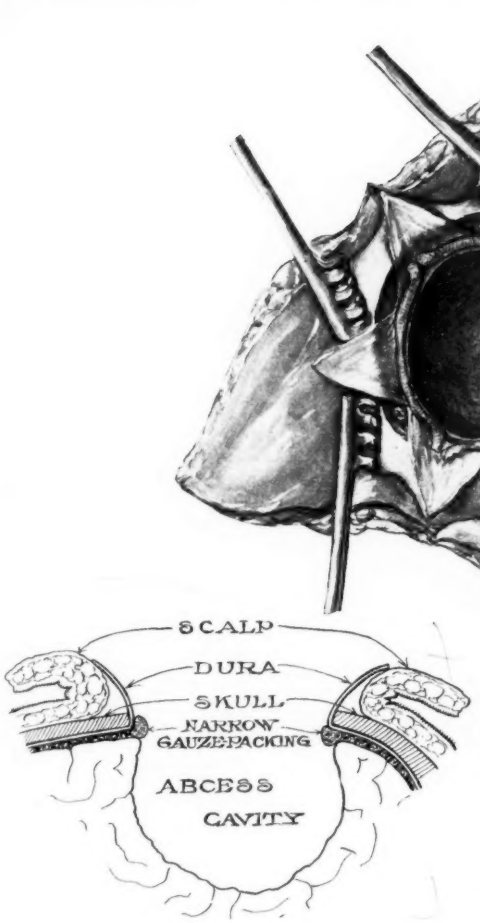
Although numerous isolated cases of recovery have been reported, secondary abscess not infrequently develops in the neighborhood of the intended drainage tract or substance employed for drainage and the case ends fatally. In many cases, rather than a real "secondary" abscess developing, a pocket of pus may accumulate in some portion of the abscess cavity and fail to be drained. This type of abscess frequently enlarges, ruptures into the ventricle, and results in death.

Numerous drainage materials have been suggested, devised, and used, among which are: gauze packing, glass tubes, rubber tubes, rubber tissue, strips of rubber dam, tubes made of wire mesh, conical shape wire mesh drains, metal searchers, etc. Although isolated cases of recovery have been reported with practically every type of drain enumerated, no author has reported any lengthy series of cases of recovery by any type of drainage, nor has the average operator been able to claim a low mortality rate. In other words, no type of drain really "drains"; that is, drains in the sense that a complete permanent obliteration of the abscess cavity takes place, followed by a high percentage of recoveries.

It has frequently been observed by various operators, that following the drainage of an abscess cavity when drainage material has been introduced and allowed to remain in position for a long period of time, the patient's condition gradually improves to the point where he is able to leave his bed and be up and walking about, and then a secondary abscess develops and terminates fatally. In my own experience with the use of rubber drainage tubes and rubber tissue, I have seen several patients recover from a stuporous or semi-comatose condition, to the point where they state that they feel well, they eat and sleep well, and are able to be up and about the ward without any serious symptoms. After a period of perhaps several weeks, a secondary abscess develops which ruptures into the ventricle and death ensues.

Drains may become dislodged and are replaced with difficulty. In fact, it has been

[1] Read before the New England Otological and Laryngological Society, Boston, Massachusetts, November 27, 1923.



Figs. 1 and 2. The soft parts overlying the outer table of the skull have been reflected; a rather large cranial defect overlying the abscess cavity has been made; the dural flaps have been reflected over the bony margins of the defect; the subdural and subarachnoid spaces have been protected by narrow iodoform gauze insinuated between the cortical surface and the dura. The "roof" of the abscess has been removed; the abscess cavity which has become more shallow at completion of operation can now become herniated or inverted through the cranial defect, making it unnecessary to use drainage material.

found at autopsy that drains have not been replaced in the sense that they follow the original tract, but are found to be inserted into the brain tissue outside of the tract. Early removal of drains and attempt to replace a dislodged drain have undoubtedly been frequently followed by fatal results. Even at the time of operation, after the abscess cavity has been partially evacuated, it has been observed that the attempt to insert a drain into the abscess cavity has failed, and at autopsy we find that the drain is in the brain tissue outside of the cavity. This is especially likely to occur in encapsulated abscesses, in which partial evacuation of the contents of the cavity is followed by a partial collapse of the cavity; and the cavity becomes "lost," so to speak. Death may also follow pressure of tubes or the displacement of a dressing. Fatal results have also followed perforation into the ventricle by drainage tubes, in attempts to replace a drain.

REASONS FOR DISCARDING USUAL DRAINAGE METHODS

In the past I have used various types of drainage material, such as rubber tubes, rubber dam, and rubber tissue and have seen the cases terminate fatally, although improvement may have taken place immediately after

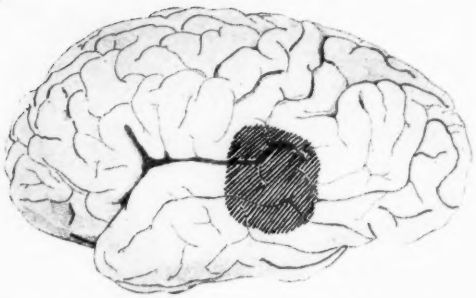


Fig. 3. Case 1. M. L. Temporosphenoidal lobe abscess, left, showing approximate position and relative size of the encapsulated abscess. There was a definite right facial paresis.

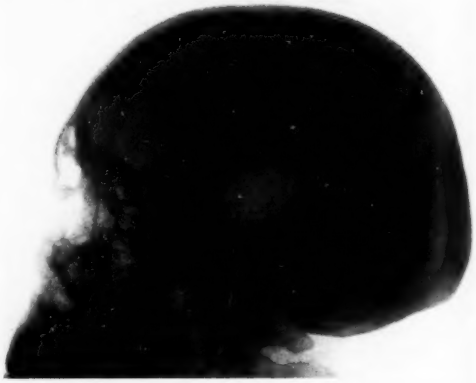


Fig. 4. Case 1. M. L. Temporosphenoidal lobe abscess, left, showing the operative cranial defect through which herniation of the abscess cavity occurred.

the operation and progressive improvement continued for several days or weeks. However, in 1920, I operated upon a case of encapsulated temporosphenoidal lobe abscess of the left side, following a simple mastoidectomy. Exposure of an area of dura about the size of a half dollar piece was made. The capsule of the abscess cavity was covered with about ½-inch thickness of brain cortex. The cavity was entered and exploration, irrigation, and cleansing of the cavity were accomplished through a crucial incision in the dura and a tract made through the cortex and capsule with an artery clamp. After the cavity had been thoroughly irrigated with Dakin's solution, we inserted drainage materials through the crucial incision, consisting of the following: a rubber tube about 2 inches long and about ½ inch in diameter, with a lateral opening at the distal end, was placed against the floor of the abscess cavity and four narrow gauze packing strips, wet in Dakin's solution, were placed about the tube. Irrigation of the larger tube was done every 2 hours by placing a small rubber tube in the lumen of the larger tube without removal of the drain.

After several days it was observed that herniation of the brain was taking place. The tube was displaced outward with the abscess cavity and about 3 weeks after operation the hernia had protruded to such an extent, with a resulting shallowing of the abscess cavity, that the tube had to be considerably shortened. A few days later the entire remaining piece of the drainage tube was removed for the reason that the abscess cavity had become so shallow that it would not retain the tube. In the meanwhile the operative site including the brain hernia was irrigated with Dakin's solution. With this treatment, the hernia began to recede and after 2 months, following the operation, the hernia had completely receded and had become covered with epithelium except for a central area about the size of a quarter. One week later, the site of the hernia was completely covered with epithelium. The patient was discharged from the hospital with complete recovery and has remained well up to the present time.

Comment. Although it was the intention of the operator to drain the abscess cavity and prevent herniation of the brain, hernia cerebri developed with extrusion of the drainage tube. In spite of the herniation which occurred with no other treatment than dakinization of the wound and dressings which prevented pressure on the hernia, the hernia receded and the wound was completely healed within 2 months and 1 week following the date of operation.

About 3 weeks after operation upon the above mentioned case, I operated on another temporo-sphenoidal lobe abscess of the left side, practically identical with the case described above. In this instance, I located the abscess cavity, entered and evacuated its contents, irrigated the cavity with Dakin's solution and instituted the same type of drainage as in the previously described case. In this instance I

Fig. 5. Case 1. M. L. Temporosphenoidal lobe abscess, left. Photograph of patient about 2 years after operation.

was able to drain the abscess through a much smaller opening in the skull, so that herniation of the brain did not take place. The patient recovered from a semicomatose condition to the point where he was able to be up and about the ward and about the hospital grounds. Secondary pockets formed on two occasions after the patient had been up and walking about, each time necessitating his return to bed, with a return of the stuporous, semicomatose condition. In each instance the cavity was again entered and drained. Following the evacuation of the first secondary pocket or abscess, the patient's general condition again improved and he was up and walking about, after which another secondary abscess formed and drainage was again instituted. Although the patient improved to a certain extent following the drainage of the second secondary abscess which developed, he never recovered to the extent observed following the drainage of the original abscess and the first secondary abscess. The infection finally spread and the patient died as a result of rupture of the abscess into the ventricle.

Several months later I operated upon a frontal lobe abscess and instituted drainage which allowed the patient to recover from a semicomatose condition to the point where he was up and about the ward, when a secondary abscess occurred with rupture into the lateral ventricle, terminating in death.

After having had this experience, I began to consider closely the questions of drainage and the desirability or undesirability of temporary herniation of the brain. In the first

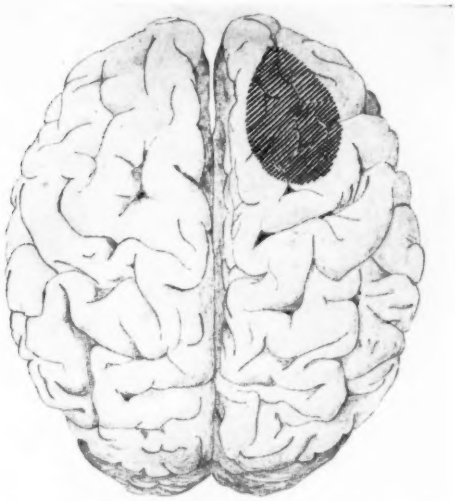


Fig. 6. Case 2. T. W. Frontal lobe abscess, right, showing the approximate position and relative size of the encapsulated abscess. There was definite left-sided hemiparesis.

case, evacuation of the abscess cavity had been accomplished through a rather large trephine opening through which a hernia cerebri subsequently occurred. The patient recovered. In the other two cases briefly described, similar drainage had been instituted through smaller trephine openings in which herniation did not occur. Both patients died.

It is also well known that during the late war, a number of deaths were prevented in cases in which there was gross cranial and intracranial injury by removal of a large mosaic of fragments of skull and considerable amounts of damaged brain tissue, with the result that subsequent herniation of the brain occurred. A great number of these patients recovered and came under the observation of the chiefs of the neurosurgical services here in hospitals in the United States, where the cranial defects were repaired. We have had cases of compound depressed fractures of the skull in Bellevue Hospital, in which the wounds were infected, suppuration occurred, and hernia cerebri developed. The hernia receded with no other treatment than protective dressings and dakinization of the wound.

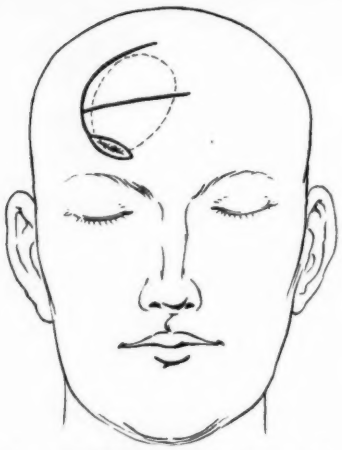


Fig. 7. Case 2. T. W. Frontal lobe abscess, right, secondary to old infected depressed fracture of skull, involving right frontal sinus. The incisions outlining the flaps for exposure of the outer table of the skull are indicated by the heavy black lines. The curved incision includes, at its lower extremity, the infected scalp wound which is excised. The approximate size of the oval shaped cranial defect to be made is indicated by the dotted lines.

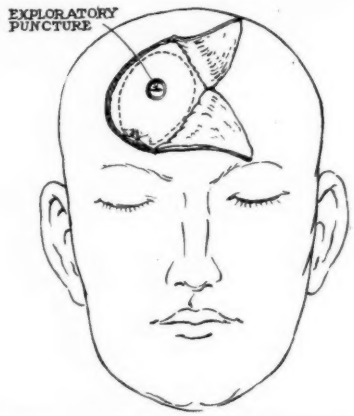


Fig. 8. Case 2. T. W. Frontal lobe abscess, right. The sketch shows the site of the trephine opening made for the purpose of exploratory puncture.

This question then arose in my mind: Why not, at the time of the original operation, provide a rather large trephine opening or cranial defect, directly over the site of the abscess; pack off the subdural and subarachnoid spaces to prevent extension of infection; "unroof" the abscess cavity by completely removing the overlying brain substance; completely empty the remaining portion of the abscess cavity; allow temporary herniation of the brain to take place through the cranial defect produced so that no drainage with drainage materials will be required; and let the subsequent treatment consist of irrigation of the area with Dakin's solution and prevention of trauma to, and early compression of, the hernia by protective dressings, which would be followed by recession of the hernia and epithelialization of the wound? After prolonged consideration, I came to the conclusion that this was the proper procedure and that cases which should come under my observation thereafter would be treated in such manner.

Three patients with brain abscess consecutively operated upon by me in this manner recovered, are well today, and are self-supporting. Upon observations made in these three cases, I have made conclusions as set forth in this paper. The etiology, pathology, symptomatology and diagnosis of brain abscess will not be discussed, as the literature is replete with papers on these phases of the subject.

TECHNIQUE OF OPERATION

Anæsthesia. Local anæsthesia with novocain solution 1 per cent and ½ per cent with suprarenin, is the anæsthesia of choice. I have seen no ill effects in the patients operated upon from the use of this solution. In most cases the patient is already drowsy, stuporous, or semicomatose.

The solution is injected in a circular direction around the site where the cranial defect is to be created. The diameter of the field is about 4 inches. This method makes it possible to inject the field rapidly and at the same time obviates entering an infected field, thus spreading the infection in case an infected wound is present. Not more than 100 to 125 cubic centimeters of the solution will be required. Dunn's apparatus for the injection of the solution has proved to be satisfactory.

Incision. The preferred incision is either three limbed, or crucial so that the point of apposition of the apices of the scalp flaps will coincide with the site of the trephine opening (Fig. 1). If a wound be present, its situation

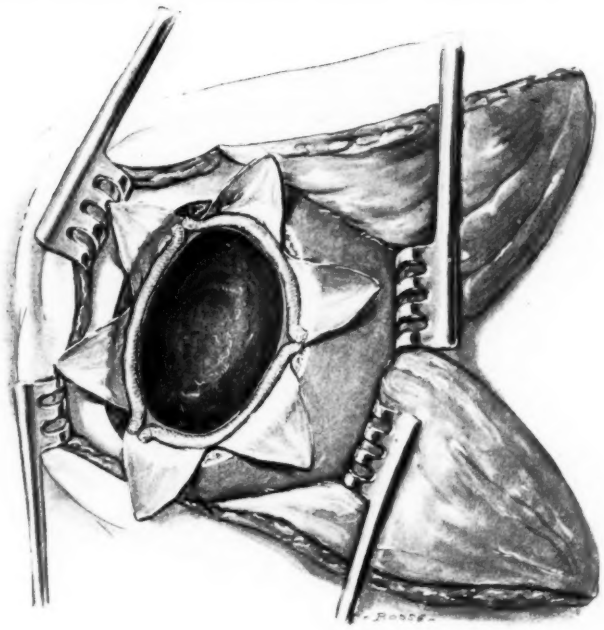


Fig. 9. Case 2. T. W. Frontal lobe abscess, right. Illustration shows the operative field as it appeared at completion of operation.

and direction may require the making of two or four flaps instead of three (Figs. 7, 8, 9). The incision is carried through to the outer table of the skull and the flaps consisting of the scalp, subcutaneous tissue, musculature and pericranium are elevated, reflected, and held with self-retaining cranial retractors (Figs. 9 and 14). The apices of the flaps are turned outward and sutured loosely to the flaps so as to prevent their becoming adherent too early to the surface of the hernia which will form, and to prevent the apices of the flaps from turning under and becoming adherent to the undersurface of the flaps. The retractors afford adequate exposure and prevent hæmorrhage from the margins of the flaps by traction and pressure, so that no artery clamps will be needed for this purpose. The exposure of the skull is therefore more rapid and is accompanied by practically no hæmorrhage. If an infected wound of the soft parts is present, this is excised along one limb of the operative incision. A trephine opening is made in the central portion of the exposed outer table of the skull with a Hudson bone drill, bits A and B being used. A small incision about ¼ inch long is then made in the dura, so as to allow of exploration with a blunt hollow needle or cannula (Fig. 9). When the abscess cavity is entered by the needle and pus is obtained, a small amount of pus is removed for bacteriological examination, the location of the abscess is indicated, the needle is withdrawn and the trephine opening is enlarged with rongeurs, until it is about the size of a silver dollar or larger. It is enlarged in a direction to correspond with, and overlie, the abscess cavity. If the abscess is located directly beneath the trephine opening, enlargement of the cranial defect will be concentric with the trephine opening. If the abscess cavity is located more anterior or more posterior or inferior, or more superior, then the opening is enlarged in the direction indicated, so that the original trephine opening may be in the periphery of the cranial

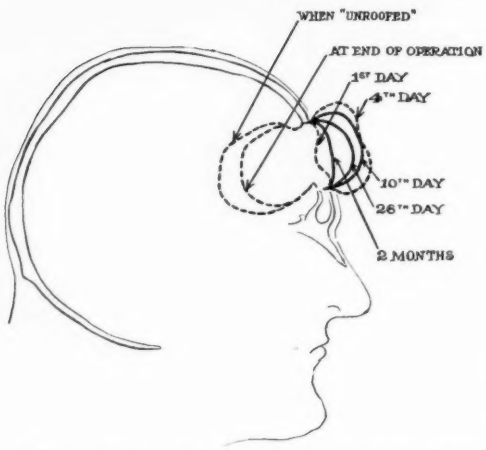


Fig. 10. Case. 2. T. W. Frontal lobe abscess, right. Schematic representation of the approximate relative size of the abscess cavity when "unroofed" at end of operation and progression and recession of hernia.

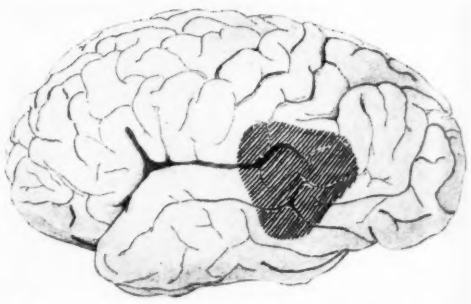


Fig. 11. Case 3. C. D. Temporosphenoidal lobe abscess, left, showing the approximate position and relative size of the non-encapsulated abscess, with extensions into the parietal lobe, occipital lobe and temporosphenoidal lobe. There was definite right facial paresis.

defect created. The dura is incised in a stellate fashion, creating six pennant shaped flaps which are reflected over the bony margin of the cranial defect, and sutured with fine plain catgut to the underlying surface of the scalp flaps. Small narrow strips of iodoform gauze (three pieces) are then lightly packed or "insinuated" beneath the margin of the circular defect created in the dura, so as to wall off the subdural and subarachnoid spaces and prevent extension of infection into these spaces. (Three short pieces of gauze are more easily removed than one long piece). The blunt exploring, hollow needle or cannula is again inserted into the abscess cavity, so as again to locate the cavity definitely, after which a ½ inch incision is made with a sharp Bard Parker knife (blade No. 11), through the brain tissue (and capsule, if one be present) overlying the cavity. A soft rubber catheter, about No. 18 F., with a 20 cubic centimeter Luer syringe attached, is inserted into the incision and most of the contents of the cavity are carefully withdrawn, to prevent the contents of the abscess from running over and soiling the field of operation.

The incision in the cortex or "roof" of the abscess is carried to a point on the margin of the cavity, then thence around it in a circular manner, so that the entire "roof" of the cavity is removed, completely "unroofing" the cavity. It is essential that a short knife should be used for this purpose. When normal brain tissue is cut, one anticipates a considerable amount of bleeding. But only slight oozing occurs when the brain tissue overlying an abscess cavity is cut and removed.

As soon as the abscess is evacuated, the patient's condition improves. The pulse which in most cases is slow, now rises to between 70 and 110. Respiration and the general condition improve, so that he is less stuporous, is more susceptible to the external influences, oftentimes is able to talk and answer questions, and may become restless and may have to be restrained on the table.

The cortical margins about the abscess cavity will fall away from the dura unless adhesions have already taken place. If adhesions are present, they should not be separated, as their presence will be of value in the prevention of spreading of infection into the subdural and subarachnoid spaces. In fact, these spaces may be completely shut off by the adhesions. The cavity is then thoroughly irrigated with Dakin's solution and gently sponged or wiped out with cotton pledgets, completely to remove the contents of the cavity. No attempt is made to remove the "capsule" if one is present. In fact, a "capsule" tends to prevent too marked herniation of the brain.

After the roof of the abscess cavity has been removed, it will be observed that the floor of

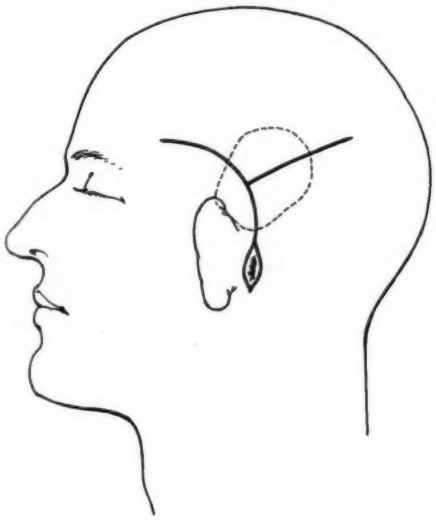


Fig. 12. Case 3. C. D. Temporosphenoidal lobe abscess, left, secondary to mastoiditis, with simple mastoidectomy. The incisions outlining the flaps for exposure of the outer table of the skull are indicated by the heavy black lines. The dotted lines show the approximate relative size of the cranial defect to be created.

Fig. 13. Case 3. C. D. Temporosphenoidal lobe abscess, left, showing the operative cranial defect through which herniation of the abscess cavity occurred.

the abscess cavity becomes less concave, flattens out and tends to rise somewhat into the operative field, thus diminishing the depth of the remaining portion of the abscess cavity (Figs. 10 and 15).

No drainage tubes or other drainage materials are inserted into this remaining portion of the abscess cavity. A fenestrated rubber dam is placed over the cavity, its margins coinciding with the operative field, over which small pieces of gauze wet in Dakin's solution are placed, so that the rubber dam "dimples" somewhat into the cavity. The original three pieces of iodoform gauze which were placed around the dural opening are not removed or changed. These pieces, during the procedure, adapt themselves to the margin of the subdural space and tend to prevent leakage into the subdural and subarachnoid spaces, better than if they were changed and new ones introduced.

The intention of the procedure, is: first, to remove the contents of the abscess cavity; and, second, to remove the roof of the cavity so as to allow the remaining portion of the cavity to herniate outward through a cranial defect which is intentionally placed directly over the abscess. The rubber dam is used to protect the surface of the after-forming brain hernia. The rubber dam offers better protection than does gauze or any other substance which might be used, in that there is no trauma to the hernia in its removal and at the same time when it is used it is possible to dakinize the hernia on account of its being fenestrated. The rubber dam is covered with a piece of gauze, wet in Dakin's solution and three perforated Dakin tubes are placed over the gauze, so that the entire area may be kept thoroughly wet with Dakin's solution[1] and a copious wet Dakin gauze dressing consisting of flats and headroll is applied.

And furthermore both ears are covered with several layers of vaseline gauze to prevent irritation by the solution. If the abscess is frontal in location, it is advisable to cover one or both eyes with vaseline gauze and include them in the dressing. Vaseline gauze is not applied to the scalp about the wound until the first dressing on the following day, as the scalp will withstand dakinization for 24 hours without irritation. The entire dressing is held in place with wet gauze bandages,

[1]An apparatus, made of rubber, has lately been devised for the protection of the hernia cerebri, which at the same time allows of convenient dakinization of the wound, thus obviating the use of a rubber dam and tubes which are likely to be displaced.

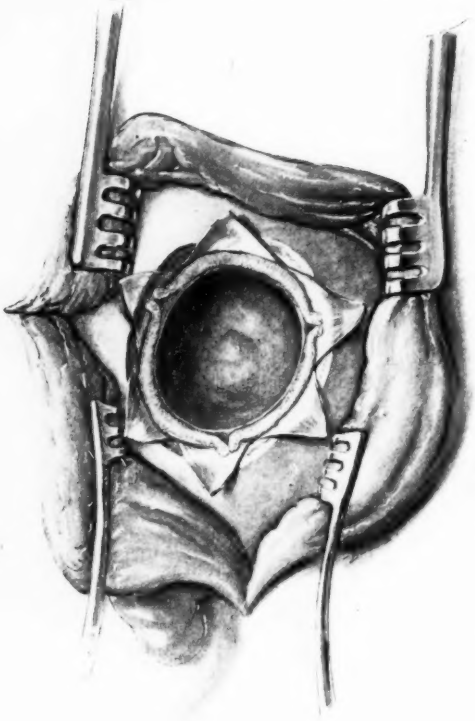


Fig. 14. Case 3. C. D. Temporosphenoidal lobe abscess, left. Illustration shows the operative field as it appeared at completion of operation.

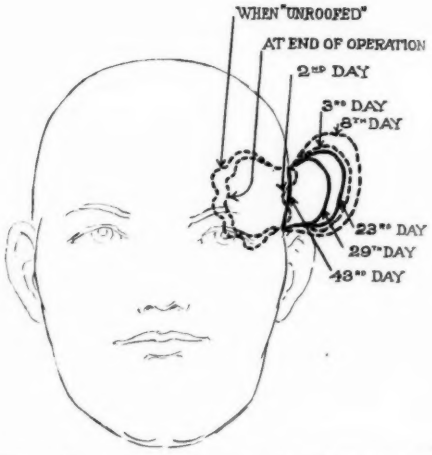


Fig. 15. Case 3. C. D. Temporosphenoidal lobe abscess, left. Schematic representation of the approximate relative size of the abscess cavity when "unroofed" at end of operation and progression and recession of hernia. Non-encapsulation of the abscess is represented by the wavy dotted lines.

including the head and the lower jaw, to prevent removal or displacement of the dressings by the patient.

This procedure is equally applicable in the treatment of abscesses whether located in the frontal or temporosphenoidal lobes (with or without extension into the parietal or occipital lobes) or cerebellar regions, or for those abscesses which are secondary to an old infected compound fracture or osteomyelitis of the skull. These groups form the greater majority of all brain abscesses. Likewise, single metastatic abscesses, which are comparatively rare, are amenable to this type of operation. For multiple metastatic abscesses, no surgical procedure can be expected to offer relief. If the abscess is located in the parietal lobe (which is unusual) necessitating a partial removal of the cortex, a monoplegia, or even a hemiplegia, is to be preferred to a fatal result. In those cases of cerebellar abscess, where the abscess is situated on the anterior surface of the cerebellum, and the lateral sinus is involved, the approach described by Eagleton (3) with ligation and division of the lateral sinus probably will give best results.

In the small remaining group of cases where the abscess is basilar in position, and no opportunity is offered for removing the wall of the abscess to allow herniation, the two stage procedure described by Dowman (2) is probably the operation of choice, if the abscess can be located.

In recapitulation, the procedure described in this paper is applicable in all cases of brain abscess, in which the "roof" of the abscess can be removed and the abscess cavity can herniate through the cranial defect. Fortunately, these cases are most frequently met with and comprise the vast majority of all brain abscesses.

POSTOPERATIVE TREATMENT

The after-care of the patient, with attention to details, is most important and should be carried out by the operator himself or by

Figs. 16 and 17. Case 3. C. D. Temporosphenoidal lobe abscess, left. Photographs of patient made on November 1, 1923, about 10 months after operation.

an assistant who thoroughly understands the postoperative care. The patient should be dressed daily for a prolonged period of time. The cardinal points in the after-care of the patient, which will result in recovery, are:

1. Allowing of temporary herniation of the brain, carrying with it the remaining portion of the abscess cavity.

2. Combating of infection by the use of Dakin's solution.

3. Prevention of trauma to the brain hernia during the period of combating infection and the subsequent recession of the hernia.

4. Prevention of overdistention of the ventricular system by means of lumbar puncture, if indicated.

5. Strapping of the wound with adhesive strips after the slight necrosis on the surface of the hernia has ceased and the surface of the hernia has become covered with healthy granulations followed by epithelialization and recession of the hernia.

Dressings. For several weeks the dressings should be done daily, beginning on the first day after operation. Dakinization of the wound is commenced immediately after the patient is returned to bed from the operating table, the instillation being made every hour.

Vaseline gauze should completely cover the scalp for protection from Dakin's solution and be removed and replaced at each dressing.

At the first dressing, all of the dressings should be removed with the exception of the

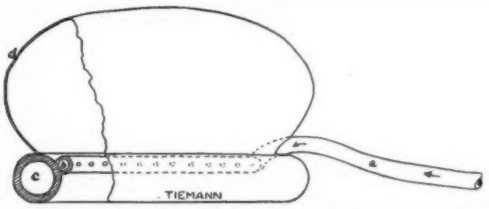


Fig. 18. Apparatus designed for irrigation of operative field with Dakin solution, and protection of brain hernia. *a*, inflow tube; *b*, circular, perforated Dakin tube; *c*, pneumatic rubber tube ring which is fastened to head to prevent displacement; *d*, perforated rubber cap to enclose hernia.

rubber dam over the defect (or the rubber protecting apparatus if used) and the three small pieces of iodoform gauze which have been placed about the margin of the defect to protect the subdural and subarachnoid spaces. At this time, i.e., 24 hours after operation, it will be observed that the abscess cavity has become somewhat herniated outward, has become much more shallow and may have reached the level of the inner table of the skull. If not, this level will have been reached by the second or third day (Figs. 10 and 15). A dressing similar to the one applied on the operating table is again applied, and the scalp covered with vaseline gauze.

This same procedure is repeated each day until about the sixth day, when the hernia of the brain will have passed out of the cranial defect and the abscess cavity will have become everted, or "turned inside out" so to speak, so that the concave floor of the abscess cavity has now become the convex surface of the hernia. The hernia is smaller in cases in which a capsule is present than in those cases of non-encapsulated abscess. At this time the hernia will have assumed a mushroom shape, overlapping the small iodoform gauze packings about the margin of the defect. These should at this time be carefully removed, so as not to traumatize the hernia. If the gauze packing is not re-inserted between the scalp flaps and base of the hernia, the scalp flaps will become attached to the lateral surfaces of the hernia, which might result in the adherence of flaps to the hernia and in the forming of small pockets at the base of the flaps in the space between the base of the flaps and the base of the hernia. In order to prevent

such an occurrence, it is considered advisable to pack lightly strips of gauze wet in Dakin's solution, between the scalp flaps and the brain hernia so as to allow the flaps to first become attached to the hernia, at the base. Throughout successive dressings, these light gauze strip packings are inserted to a lesser depth than on the preceding day, thus allowing the scalp flaps to become gradually attached to the hernia from the base upward. When the space between the base of the flaps and the base of the hernia has been obliterated, the loose sutures which have held the apices of the flaps in an everted position are removed, and the flaps allowed to become adherent throughout to the lateral surface of the hernia. Care should be taken that the apices of the flaps do not roll inward upon the flap and become adherent to the undersurface of the flap or that the margins themselves do not roll in. If so, the hairs from the scalp will grow outward and downward against the surface of the brain hernia, irritate the surface of the hernia, prolong infection, and delay epithelialization at this area. The holding of the apices of the flaps in an everted position for several days will prevent this occurrence.

The hernia may become of considerable size, from the size of a small lemon to that of a small orange; that is, a mass from about 1½ inches in diameter to that of 3 or more inches in diameter and protrude above the level of the scalp for a distance of 1 to 2 inches. *The hernia should not be cut away;* neither should it be compressed *at this time.* To prevent compression, if the apparatus suggested for this purpose is not used, a ring made of cotton wrapped with gauze (such as is placed about a patient's heel to prevent a pressure sore), is placed about the hernia and strapped to the head to prevent displacement of the ring. The hernia is kept protected with a rubber dam or apparatus and the entire area is kept thoroughly irrigated with Dakin's solution. In other words, after the hernia has formed, it is necessary to (1) protect the hernia from pressure and trauma, (2) prevent overherniation by lumbar puncture, (3) keep the area thoroughly irrigated with Dakin's solution, (4) keep the patient quiet in bed during the first 3 or 4 weeks, while the hernia is at its maximum size, and to prohibit physical exertion. Bowels should move daily.

To prevent excessive herniation of the brain after the abscess cavity has become everted, lumbar puncture, with removal of 10 to 25 cubic centimeters of fluid from time to time should be done, after the first 2 weeks have passed. By this time the area about the defect has become well walled off and the likelihood of spreading of infection in the meninges will have passed. The size of the hernia will immediately decrease during the lumbar puncture, while the fluid is being withdrawn. The herniating mass instead of being tense will become soft, "flabby," somewhat flattened out, and may even become depressed in its central portion. In case of temporosphenoidal lobe abscess, where the herniating mass consists of brain tissue for the most part, the recession of the hernia following lumbar puncture will not be as great as in the case of a frontal lobe abscess, where the herniating brain substance is thinner and the surface of the anterior horn of the lateral ventricle is nearer the surface of the brain hernia. In such a case, that is, a frontal lobe abscess, the hernia recedes entirely within the cranial cavity and forms a depression. In such cases, the amount of fluid removed by lumbar puncture should be less, so as not to create a negative pressure within the ventricle and thus bring about the danger of possible rupture into the ventricle from without. The intention should be to remove only enough cerebrospinal fluid to lessen the intracranial pressure sufficiently to do away with the possibility of rupture of the ventricle from within outward, through the hernia, from marked increase of intracranial pressure. Lumbar puncture should not be done in the first few days following the operation, for fear of extension of infection.

In the cases observed there were slight areas of superficial sloughing of the hernia. These areas of sloughing were on the surface and were not greater than one-sixteenth to one-eighth inch in depth. It has not been observed that they have been deep seated or tended to extend into the depth of the hernia, but have always been limited to thin superficial sloughing. These superficial sloughs should not be

removed until after they have become completely loosened (except that the margin which has already become loosened should be clipped away with scissors), i.e. no attempt should be made to dissect the slough away from the brain tissue. If so, slight bleeding will occur with the possibility of extension of infection into the hernia and a repetition of the sloughing at this site. The slough which has been observed has been chiefly that of the wall of the everted abscess cavity itself and the cut margin of brain substance about the original abscess cavity, made by the knife in "unroofing" the cavity. Gross sloughing of the hernia itself has not taken place.

After about 3 or 4 weeks, the surface of the hernia will become covered with healthy red granulation tissue, which will give a greater resistance to the surface of the hernia. The surface will become somewhat fibrosed and will not increase suddenly in size with coughing and sneezing as it does in the earlier stages before fibrosis or partial cicatrization has taken place. The hernia will also begin to diminish in size, becoming less and less from day to day. It will be observed that epithelium has begun to grow out over the surface of the hernia, extending from the margin of the scalp flaps. At this stage the surface of the hernia should be covered with strips of perforated adhesive plaster exerting slight pressure. To fix the adhesive so that it will not be loosened by the Dakin's solution, a strip of adhesive about 2 inches wide should be placed around the head so that the ends come to within about 3 inches of either side of the site of the hernia. To this strip of adhesive the several smaller pieces of adhesive covering the hernia can be fastened and they will not be loosened by the Dakin's solution. These strips should be removed daily during the first week or two of strapping of the hernia, on account of the secretion which accumulates about the strips. A gauze dressing wet in Dakin's solution should be applied over these strips and it should be kept wet with Dakin's solution and a syringe, from without, every 2 or 3 hours. At this stage, it will no longer be necessary to use the Dakin tubes. The epithelium grows rather rapidly beneath the adhesive strips, so that finally only a small granulating surface remains after the area has been strapped for about 2 weeks. The patient ordinarily will be up and about the ward by the time the strapping is commenced. The small granulating area in the center of what was the hernia, finally becomes completely covered with epithelium, leaving a healthy non-hair-bearing scar, usually somewhat triangular or crucial in shape, this being the space between the margins of the retracted scalp flaps.

The average time which will be required from the time of operation until the hernia has completely receded and the granulating surface has become covered with epithelium is about 2½ to 3 months. The level of the site at which the hernia occurred, has now become flattened, the hernia is completely subsided, or the area may even be slightly depressed. The case will then show the typical physical signs of the usual cranial defect, i.e. there will be present, pulsation corresponding to the heart beat, impulse on coughing or sneezing, a tendency to slight herniation when the patient leans toward the side on which the cranial defect is situated and a slight depression when the patient leans in the opposite direction.

Hernia cerebri in general. The treatment described above applies to hernia cerebri in general. We have demonstrated this to our satisfaction in the last 2 years in Bellevue Hospital. All cases which I have seen treated in this manner, at this hospital, have recovered.

LATER OPERATIVE PROCEDURES

Scalp plastic. After a period of 1 year or more, following complete healing of the wound a scalp plastic with excision of the non-hair-bearing scar and approximation of hair-bearing scalp edges, is advisable for the following reasons, in certain cases:

1. Elimination of the rather thin scar overlying the brain substance, which might be more easily traumatized than true scalp, thus resulting in a secondary infection.

2. Preparation of the site for cranioplasty or repair of the cranial defect at a much later date, in case this is desired.

3. Protection.

4. Cosmetic reasons.

The scalp plastic, however, should be deferred for a period of 1 year to 14 months, so as to avoid the possibility of latent infection.

Cranioplasty. After a period of about 1½ to 2 years, following the original operation, the cranial defect can be repaired according to the method used by us in the neurosurgical services in the late war and also in the hospitals in civil practice. This subject will not be discussed as it was fully covered in a previous paper (5).

Report of Cases[1]

Case 1. M. L. New York Eye and Ear Infirmary. No. 2838. Russian Hebrew, age 28; occupation, cutter of men's clothes. Service: Dr. John McCoy. Admitted to hospital July 5, 1920.

Four weeks before admission, patient had severe pain in left ear. On following day the ear drum was punctured and drained for about 10 days. Drainage suddenly ceased following which there was pain behind the ear in region of mastoid process. On day previous to entering hospital there was pain and swelling behind left ear.

July 7, 1920, simple mastoidectomy, left.

July 22, 1920, *operation* for brain abscess—temporosphenoidal lobe, left. The abscess was encapsulated and contained thick, yellow pus—streptococcus. The cortex overlying the abscess cavity was about 1.2 centimeters thick.

A large opening was made into abscess cavity and a short, thick, rubber drainage tube inserted. This was held with four gauze packings. Herniation of abscess cavity occurred and was complete on about thirteenth day, with eversion of abscess cavity. Treatment consisted of irrigation with Dakin's solution. Thirty days following operation the hernia had markedly receded. Fifty-seven days after operation hernia had completely receded, with no treatment other than keeping the area clean with Dakin's solution. Sixty days after operation the wound was completely healed. Highest temperature 101.2 degrees on second day.

In this case, herniation of brain was not intended nor desired; it occurred, however, resulting in eversion of the abscess cavity, without formation of secondary abscess. Recovery.

Follow-up-note. November 14, 1923. Patient stated that he was discharged from New York Eye and Ear Hospital on October 7, 1920, to his home. He was not confined to his house at any time since his discharge from the hospital. He went out daily and looked for work. He felt perfectly well. He was unable to obtain work until about 10 weeks after his discharge on account of a strike, at the end of which time, however, he succeeded in getting a position as a cutter of men's clothes; a position similar to the one which he held before his illness. He continued at this work without interruption, except for his yearly vacation, until September, 1923. He then gave up his position and opened his own store at Coney Island. He is part owner of a Cigar and Stationery Store and Ice Cream Parlor, and continued at this until the present date. This work, in addition to his usual duties wihin the store, entails delivery of newspapers to the residents of Sea Gate, and requires a considerable amount of walking. He was married in November, 1921. At the present time he is in perfect health and has no complaints whatsoever. While in the hospital in July, 1920, before the mastoid operation, he weighed 135 pounds. Upon discharge from the hospital—155 pounds; after having remained at Burke's Foundation for about 2 weeks, at which time he returned home, he weighed 165 pounds. At the present time, 3 years and 4 months following operation, his weight is 175 pounds.

Otological examination. (Dr. Stuart L. Craig), November 2, 1923: "His hearing is practically normal. Drum shows some scar tissue in posterior segment and some thickening, but is in fair position. The mastoid area shows a depressed scar, edges smooth and entirely healed. The area over the temporosphenoidal lobe shows no hernia."

Case 2. T. W., Bellevue Hospital—Brain Abscess No. 15, male; Russian Pole; age 46; occupation, blacksmith; admitted Second (Cornell) Medical Division, March 17, 1923.

On February 22, 1923, while working as a blacksmith in a round-house for a railroad company in Pennsylvania, he fell and struck the right side of his forehead against an upturned chisel and received a wound of the right frontal region. He was not unconscious. The wound was sutured by the company's doctor without roentgenographic plates having been made. He remained in the hospital about 10 days, at the end of which time he again resumed his work for a period of 5 days. On account of pains in his head he gave up his work. The wound never completely healed. He had severe pains in his head which he tried to relieve by drinking liquor. He came to New York and walked to Bellevue Hospital to which institution he was admitted.

Physical examination. Patient had an inflamed, lacerated wound about 1½ inches long, in right frontal region. General physical examination was negative. Three days after admission he developed slight facial weakness of left side. Seven days after admission patient was decidedly lethargic but when aroused he could talk. He was unable to use his hands properly, especially the left hand. He had a slight left facial weakness, spasticity of left arm and leg, choking of both discs, increased reflexes on both sides. Ophthalmological note: No nystagmus. No paresis or paralysis of ocular muscles. Right pupil greater than left; very slight response to light. Fundi: papillœdema, right, with circumscribed retinal œdema. Numerous hæmorrhages and spots

[1] A summary of each case is given in this paper on account of limitation of space. The complete case reports will be given in the reprints.

of exudate. Left fundus: optic neuritis with little elevation of disc. Diagnosis: brain abscess, frontal lobe, right, secondary to compound fracture right frontal region.

March 26, 1923, *operation* for brain abscess, frontal, right. Local anæsthesia was used. A large encapsulated pear-shaped abscess was evacuated of thick, yellow pus—streptococcus hæmolyticus. Exposure was done by making a large cranial defect overlying the abscess cavity with frontal sinus curettement and removal of overlying cortex about 1.5 centimeters in thickness. No drains were used. There was partial herniation of abscess cavity before the operation was completed: maximum herniation about seventh day after operation. Dressings were changed daily and wound was dakinized. A rather thin-walled hernia overlying the anterior horn of the right lateral ventricle completely receded in 71 days. There was no leakage of cerebrospinal fluid. Highest temperature 100.6 degrees on third day after operation. He was discharged from Bellevue on one hundred and first day following operation with no complaints. Weighed before injury 166 pounds; weighed 132 pounds before admission; weighed 170 pounds when discharged from hospital. General condition excellent. Recovery.

Follow-up-note. No information was received about patient until August 22, 1923, when it was reported by an attorney for the Polish Missions for the Diocese of Pennsylvania that he was in Philadelphia. On November 8, 1923, it was learned that he had gone to West Virginia where he had resumed work.

Case 3. C. D., Bellevue Hospital Brain Abscess No. 14; male; age, 26; occupation, fireman, New York City Fire Department; admitted March 26, 1923. Service of Dr. T. A. Smith, Director of 4th Surgical Division.

Patient stuporous and could give but little history. From his sister it was learned that 3 weeks before admission he was operated upon in another hospital for mastoiditis, left side, simple mastoidectomy being done. Previous to the mastoid operation he had influenza, after which his left ear drum was punctured.

Physical examination. Patient was stuporous but could be aroused by examination. Answers questions very slowly. Blood pressure 120–80. Temperature 100 degrees. Pulse 70.

Neurological note. Patient stuporous and therefore incooperative. Local condition was not examined. There was bilateral early papillœdema, right greater than left. Slight facial weakness and pyramidal signs present on right side; astereognosis, right side. Impression of superficial examination; brain abscess, temporoparietal, left.

Neurosurgical note: Diagnosis: Brain abscess, temporosphenoidal lobe, extending into parietal lobe, left, secondary to mastoiditis, with simple mastoidectomy, left.

Cardinal points: (1) Drowsiness or stupor; (2) infected postoperative wound following operation for mastoiditis, left with inflammatory zone about wound and unhealthy granulation tissue in wound; (3) astereognosis, right; (4) history: symptoms beginning about 2 or 3 weeks after radical operation for mastoiditis; (5) engorgement of retinal veins, especially left; (6) sensory aphasia; (7) right facial weakness.

Operation for brain abscess advised, to be done as soon as possible.

Otological note. Right ear negative. Left ear shows postoperative simple mastoidectomy. Drum is grey. There is no bulging or signs of an acute middle ear infection. Postauricular wound has small piece of old gauze packing: on removal a dirty wound was seen filled with seropurulent material. Granulations were present beneath and are of an unhealthy type. No connection is noted between the antrum region and wound. No cordlike mass is felt in neck.

Diagnosis of temporosphenoidal lobe abscess is concurred in and operation advised.

Through the courtesy of Dr. T. A. Smith, patient was transferred to Second (Cornell) Surgical Division for operation.

March 27, 1923, *operation* under local anæsthesia. Pathological findings: external mastoidectomy wound as described above. Dura had been exposed at time of last operation, to an area about size of a dime. At this site the dura is adherent to cortex. Through a trephine opening made about 1 inch above the exposed area of the dura a puncture was made with a blunt brain cannula, and rather thin, oily pus was obtained at first puncture—staphylococcus aureus. Opening was enlarged until a cranial defect about 2 inches in diameter was made. Cortex about 1 centimeter thick overlying abscess cavity was removed. The abscess was non-encapsulated. First contents evacuated were rather thin oily pus; residual contents of cavity thick and contained necrotic brain material. Abscess considered to be of rather recent formation. Herniation of floor of abscess noticed on table. No drains.

Summary of postoperative course. Dakinization of wound and daily dressings. A large brain hernia reached its maximum about eighth day. There was complete eversion of abscess cavity. The hernia completely receded in 44 days aided only by one lumbar puncture on thirty-first day. Dakin's solution was used throughout. Dressings were applied to protect and to prevent compression for thirty-nine days, after which there was applied a slight compression dressing with granulating surface covered with adhesive plaster strips. Highest temperature 100.8 degrees F. on first day after operation. There was leakage of clear cerebrospinal fluid through hernia from seventh to twelfth day. Patient discharged on sixty-seventh day. Weighed 145 pounds when first out of bed; weighed 170 pounds when discharged. General condition excellent. Recovery.

Follow-up note. November 14, 1923. Returned to duty as fireman in New York Fire Department—"watch duty" and messenger—September 7, 1923, 5 months and 11 days after operation. This duty

entailed work both during the day and at night. October 6, 1923, transferred to day duty as inspector of garages, fire hazards and so forth; is on this duty at the present time. He now weighs 190 pounds. His general condition excellent, November 23. Although homonomous hemianopsia developed after hernia had reached its maximum and persisted until after hernia subsided, at present time patient's vision is normal. He says that he feels as well as he ever did.

CONCLUSIONS

1. Various operative procedures heretofore described, in which numerous kinds of drainage materials were used, have usually been followed by a high mortality rate.

2. In all of these procedures described, prevention of hernia cerebri has been desired.

3. In this paper the following is advised:

a. Creation of a rather large cranial defect directly over abscess cavity;

b. Complete "unroofing" of the cavity;

c. Complete herniation or eversion of the cavity;

d. Dakinization of area throughout treatment;

e. Prevention of trauma and early compression of hernia cerebri;

f. Recession of hernia;

g. Adhesive plaster strapping;

h. Epithelialization.

4. Results. Three cases which were consecutively operated upon and treated in this manner have recovered. There was no mortality in this series of cases.

NOTE: I am indebted to Drs. John McCoy and Stuart L. Craig of the New York Eye and Ear Infirmary for the courtesy of permitting me to operate upon Case 1; to Dr. John A. Hartwell, director of the Second (Cornell) Surgical Division, Bellevue Hospital, for permitting me to operate upon Cases 2 and 3, as well as for helpful criticisms of the paper; and to Dr. De Witt Stetten for his aid in general in the writing and criticism of the paper.

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PSEUDOMYXOMA PERITONEI[1]

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FORTY years ago Werth gave the first clear description of a clinical entity which he called pseudomyxoma peritonei. He defined it as "a change in the peritoneum which is a complication of ovarian cysts. . . . It is caused by a peculiar reaction of the peritoneum to the jelly-like material which has escaped into the peritoneal cavity by way of spontaneous perforation of ovarian cysts."

He says further: "At the operation or autopsy the peritoneal cavity in these cases is found filled with gelatinous material in its entire extent. This material is found partly lying free, partly in the form of thick semitransparent layers lying on and firmlyattached to the abdominal wall and the intra-abdominal organs. The masses contain delicate connective-tissue membranes and fine vessels. At times the gelatinous substance is enclosed in a delicate connective-tissue membrane and forms, especially on the intestine polypoid pedunculated structures."

Werth's definition specifies that at least part of the colloid material must be firmly attached to some one or more abdominal organs and the term of pseudomyxoma peritonei should be limited to cases presenting this feature. Many ovarian tumors show rupture and escape of their contents into the abdominal cavity, but as long as none of this material has become a part of some organ in the abdomen, we can not properly call the case one of pseudomyxoma peritonei.

On the other hand, if an appendix, for instance, has become a cyst with colloid contents and some of these contents has escaped into the peritoneal cavity or its lining within a limited radius from the appendix, even without filling the whole cavity, the condition might properly be called pseudomyxoma peritonei (for instance the cases of Vecchi, Tomita's own case and the case of Ribbert's which he reports, the case of Loth, Honecker's Case 2, Goedel's case, the cases of Neumann and Hueter).

The literature contains a considerable number of cases of cystic appendix with more or less colloid contents, but the dividing line between cystic appendix and pseudomyxoma peritonei lies in Werth's criterion of colloid material lying on and firmly attached to the abdominal wall and the abdominal organs.

After Werth's first description numerous cases were reported, mostly by gynecologists who observed pseudomyxoma peritonei in connection with ruptured ovarian cysts. But in 1901 Fraenkel first described the same condition in a man and demonstrated the origin of the gelatinous masses from the ruptured appendix. Since then numerous cases have been found in man originating in the appendix. The same finding in women is recorded by Honecker, who reports an early stage of pseudomyxoma peritonei in a woman of 50 years who had normal ovaries. Michaelson reports gelatinous material in the abdomen surrounding and escaping from a perforation in the appendix with the adnexa normal. Cramer reports a woman of 50 with the abdomen full of jelly and both ovaries quite normal.

A most remarkable case is reported recently by Lauche and later by Schildhaus, who found pseudomyxoma peritonei in a man starting from cysts originating in an umbilical tumor of the omphalomesenteric duct.

A last variation in the etiology of pseudomyxoma peritonei is supplied by those very rare cases in which both ruptured ovarian tumors and perforated cysts of the appendix furnished the material which filled the abdomen.

This finding is reported by Bailey, who reports the case of a woman of 52 years whose abdomen was found full of gelatinous material and to contain a left ruptured ovarian pseudomucinous kystoma and an appendix 7 centimeters long and 2.5 centimeters in diameter which showed a perforation at the tip and gelatinous material at this point.

While in Bailey's case an actual opening in the appendix wall is demonstrated, in other

[1] Read before the Chicago Gynecological Society, May, 1924. (For discussion see page 672).

cases of combination of pseudomyxoma peritonei with ovarian tumors and distended appendix the reports contain no statement of any open communication between the jelly in the appendix and the free peritoneal cavity.

Such cases are reported by Novak (two cases), Christiani, Pfannenstiel. In other cases pseudomyxoma in connection with ovarian tumors was found in a first operation while a cystic appendix was discovered in a subsequent operation. Such cases are reported by Eden and Rathe.

Or the pseudomyxoma peritonei was discovered in a first operation for hernia and the cystic appendix was not found until the postmortem as in Hueter's case.

Bland Sutton reports three cases in which he found cystic appendix with bilateral cystadenomata of the ovaries, without mentioning pseudomyxoma peritonei.

This much is certain, that the finding of a cystic appendix, together with ovarian kystomata, is not a rarity.

Two perfect examples of combined ovarian pseudomucinous kystoma and pseudomyxoma peritonei with open colloid cyst of the appendix occurred in my practice, the first in 1907 and the second in 1923.

In 1907 Dr. Naylor of Missouri brought me a patient of 57 years with the following history:

Mrs. M. C. had a menstrual record without abnormalities. She had had two normal labors, in her nineteenth and twenty-third years, with normal puerperiums. At the age of twenty-seven she had one abortion of 3 months without known cause and without pathological sequelæ. Her menstruation had appeared last at her forty-third year.

She had had influenza repeatedly, but was otherwise in good health until her fifty-first year when she was taken sick with pain in the region of the appendix and fever, but no vomiting. She was sick 9 weeks and her physician diagnosed appendicitis. After this attack she suffered from constipation sometimes and passed blood at stool. In her fifty-fifth year she began to notice that her clothes seemed tight and for 9 months previous to my examination she had noticed a tumor in the abdomen and pain in the region of the appendix. She was constipated, had poor appetite, had some incontinence of urine on pressing or coughing. She had weighed 104 pounds when 54, and now weighed less than 90 pounds.

The patient appeared thin and in discomfort. Varicose veins on the right leg were the only abnormal findings except those in the abdomen.

The abdomen was evenly distended by a tumor which presented dull sound on percussion and distinct fluctuation on palpation. There was no distinct dulness in the flanks. The circumference of the abdomen was 90 centimeters. Vaginal examination showed moderate laceration of the perineum, slight cystocele and rectocele, uterus high up in front, small. Behind the uterus the cul-de-sac contained indefinite soft masses through which the lower convexity of the tumor could be palpated.

Operation was performed June 14, 1907.

When the abdominal cavity was opened in the mid line, colloid material in large quantities floating free in the peritoneal cavity escaped. The tumor was the size of a woman's head and belonged to the left side. It was a kystoma without any twist of the pedicle. The tube was stretched across it. The broad ligament formed a convenient pedicle. At the lower end of the tumor was a perforation out of which colloid masses were seen escaping. The tumor was easily removed and the colloid masses dipped out of the cavity. The right ovary and tube were perfectly normal, but atrophic and were removed.

The appendix was embedded in colloid material. It was removed flush with the cæcum without leaving any stump and the resultant opening in the cæcum was closed by sutures. Colloid material was wiped off the peritoneum, the omentum, and the intestine wherever accessible.

A small nodule which was felt in the umbilicus gave the indication for an extension of the abdominal incision sufficient to excise the umbilicus before the abdomen was closed by suture in layers.

The ovarian tumor was a multilocular pseudomucinous kystoma with a round opening the size of the palm of the hand which communicated freely with the largest cyst of the tumor mass and from which colloid material was flowing.

The appendix was thickened. After the colloid material with which it was surrounded had been detached as far as possible, an opening at about the middle of the appendix was seen which had a smooth edge and from which a papillomatous mass protruded which was covered with colloid material.

The second case came to observation in 1923.

Dr. Izaakovitch consulted me with his patient Mrs. F. L., 40 years old, who had suffered from cough and choking spells for 11 years. These spells had become milder for the last 2 months. Her menstruation had begun at the age of 12 and returned regularly. It now appeared a few days too soon, and lasted 3 to 4 days with moderate loss of blood without pain. The last menstruation had begun October 20, and had lasted 5 days. The patient had had three labors, the last in 1918. They, as well as one abortion of 6 weeks in 1913, had had no pathological sequelæ.

The patient had a slight vaginal discharge, no bladder disturbance, but poor appetite, some belching after eating, no vomiting, no constipation. She

had increased in weight. For the last few months she had noticed gradual increase of her abdomen with almost no pain, but some discomfort on stooping and a feeling as if something were moving around in her.

The examination showed slight varicose veins of both legs and a few diffuse râles over both lungs. Otherwise, aside from the abdominal findings, there were no abnormalities. The urine was normal.

The abdomen was distended moderately. There was a small umbilical hernia, and no dulness in the flanks. A cystic tumor could be felt arising out of the pelvis to two fingerbreadths above the umbilicus. It fluctuated distinctly. No separate nodules were to be felt on it. There was some mucous discharge from the vagina, no infection of the urethra or labial glands. The anterior and posterior wall of the vagina protruded considerably. The uterus was in normal position. It could be felt bimanually in front of the tumor. The tumor filled the cul-de-sac. The ovaries could not be palpated separately. There were some small external hæmorrhoids.

The operation was performed November 12, 1923. It consisted of a vaginal plastic and the laparotomy. The abdomen was opened by median incision from the symphysis to a little to the left and above the umbilicus. The omentum appeared in the incision, red and covered with some colloid material. It was pushed up by the tumor which appeared to the right of it. The tumor was the size of a man's head. On the posterior aspect of the tumor was a circular opening the size of the palm of the hand with smooth edge, out of which colloid material was escaping in streams. Colloid material was further found in the cul-de-sac, in front of the uterus and lying on the intestine. A smaller tumor of the left ovary was found in Douglas' pouch and was intact. Both tumors were removed easily and then the jelly was dipped out of all readily accessible parts of the peritoneal cavity and wiped off the omentum, intestines, and mesentery. The gall bladder was found soft and free from stones. It was not covered with colloid material.

The appendix was distended to the thickness of a thumb at its middle and was covered with firmly attached masses of colloid material. It was removed. Excision of the umbilical hernia, ventrofixation of the uterus and suture of the abdominal walls in layers completed the operation.

The histories of these two patients present the type common to benign ovarian tumors. The record of a preceding attack of appendicitis is not a prominent feature considering the general frequency of appendicitis.

Preceding attacks of appendicitis have been noted quite frequently in cases of pseudomyxoma peritonei which originated from the appendix alone, in the female by Honecker in his second case, by Neumann, Cramer, and others, while they have been recorded for the male by Honecker in his first case, by Hartmann and Binet, and by Loth. However they are not recorded uniformly.

The rupture of the ovarian tumors did not appear to produce any symptoms noticeable to the patients in my cases or for the matter of that, as a rule, in the cases recorded in the literature.

The appearance of the peritoneal cavity in the two cases reported here corresponded closely to Werth's descriptive definition aside from the presence of the ruptured appendiceal cysts.

The ovarian tumors in both cases were simple pseudomucinous cysts of typical structure without any signs of malignancy. The same finding is recorded in all descriptions of this kind of case with the exception of the cases of Strassmann and Wendeler, who found mixed tumors. Wendeler found hair and fat besides the colloid producing part of the tumor and Strassmann found an enormous ovarian teratoma.

The appendix of the first case is about the thickness of the little finger; it is five centimeters long and presents an opening the size of a pea at the antimesenteric border at the middle of its length.

Cross sections of the appendix at the cæcal end show complete obliteration, cross section through the middle shows a cavity from which the warty growth protrudes and cross sections through the distal end again show complete obliteration.

Microscopically the obliterated cæcal and distal portions of the appendix show the center of the appendix formed by connective tissue and fat with only very minute groups of lymphoid tissue without any mucosa or muscularis mucosæ. The circular and longitudinal musculature of the appendix is well preserved and strong. On the outside of the serosa, masses of mucus are seen in which fine capillaries, fine strands of connective tissue, a few lymphocytes and some connective-tissue cells with brown pigment are seen.

The central part of the appendix shows an irregular narrow lumen which is mostly filled by the tumor mass (Fig. 1) which consists of fine papillæ with a high cylindri-

cal epithelium. The papillæ contain small amounts of connective tissue and fine capillaries. The epithelium is high cylindrical with many goblet-cells. The cells are frequently arranged in sheaves and fine streamlets of mucus are seen starting out from the papillæ. Some of the papillæ have lost their epithelium and their connective tissue is exposed and covered with mucus containing some red blood cells. The circular and longitudinal musculature at this point is quite as thick as in a normal appendix and shows a gap at which the muscular layers turn outward, pushed apart by the protruding papilloma.

No epithelial cells are seen free in the masses of mucus on the outside of the appendix. The peritoneal epithelium is nowhere visible where the mucus on the outside is in direct contact with connective tissue of the subserosa from which the fine strands of connective tissue and the fine capillaries penetrate into the superimposed mucus. At the points where no mucus is lying on the appendix the peritoneal epithelium is well preserved, especially in every little recess.

The appendix of the second case, 6 centimeters long, is of the thickness of a thumb at its middle and covered with colloid material on the outside. At about its middle (Fig. 2) it shows at the antimesenteric border a transparent nodule the size of a pea, also covered with colloid material. After hardening, the appendix is cut across at this point. The cross section (Fig. 3) shows a narrow duct communicating at one end with the widely distended lumen of the appendix and at the other end opening in a little mass of jelly which is continuous with jelly covering the rest of the outside of the appendix. The lumen of the appendix appears as a roundish cavity the size of a hazelnut and contains clear mucus of rather thinner consistency than that escaping from the ovarian tumor. The lining of the cavity appears macrosopically smooth.

At both ends of the cavity in the appendix there is complete obliteration.

The wall of the cavity consists of an outer layer with some of the mucus attached to it, then a much thickened longitudinal and circular layer of muscle. The circular layer is lined with a high cylindrical epithelium which in many places rises up in very delicate papillæ with a minute connective-tissue core covered with a very high columnar epithelium with many goblet cells (Fig. 4). The epithelium is crowded together so that in many places it rises in sheaves. At no place is there any multiplicity of layers or any invasion of the underlying tissue.

Sections through one wall of the diverticulum leading into the peritoneal cavity show the muscular tissue of the appendix turning into the wall of the diverticulum, but soon lost, leaving nothing but connective tissue forming the wall (Fig. 5). The diverticulum has no epithelial lining. The epithelium of the appendix stops a short distance from the inner opening of the diverticulum as a microscopic ridge of epithelial cells such as is often seen where epithelial lining ends at the edge of a raw area (Fig. 6).

Neither in the mucus at the outer mouth of the diverticulum nor in the mucus surrounding the entire diverticulum is there any trace of epithelial cells. The mucus is attached to the outside of the diverticular connective tissue frame work and is permeated by fine capillaries and scant connective tissue.

It would be easy to find areas in both of these appendices which look so much like ovarian pseudo-mucinous kystomata that were it not for the muscular wall of the appendix one could easily be mistaken for the other.

In many reported cases of pseudomyxoma peritonei originating in the appendix it is stated that the inner lining of the appendix was perfectly smooth, but our second case shows that it is always necessary to control such statements by microscopic investigation. The lining appeared perfectly smooth in this second case, but the microscope demonstrated distinct papillary tumor formation. The minute papillæ of the second case are evidently an earlier stage of the high and extensive papillary growth which was observed in the first appendix.

I find only one similar report in the literature. Novak's Case 1 showed a papillomatous mass embedded in gelatine in the cystic appendix.

Formation of diverticula in cystic appendices is not rare and a number of cases are

reported in which the diverticula were so thin walled that communication with the abdominal cavity under the pressure of the mucous contents might readily be expected to take place at some time even if it was not present at the time of operation. It is quite within the possibilities that such diverticula may open up under pressure and then, when by escape of the cyst contents the pressure is relieved, may heal shut again until the pressure increases again and the process repeats itself. The fact that the diverticulum in Case 2 had no epithelial lining is suggestive in this respect. If the diverticulum had an epithelial lining, it would be unlikely to heal shut even temporarily, but walls consisting of connective tissue alone may readily agglutinate and close for a time and give way again under pressure. Cystic appendices may give way and discharge mucus even without diverticulum formation. The muscular wall, thick as it is, and the cleft-like lumen of the appendix in the first case represent well the stage of the collapsed appendix after expulsion of the contents through a gap in the wall without a diverticulum.

The numerous cases reported in which cystic appendix was found, together with pseudomucinous kystoma of the ovary are therefore all potentially at least in the same group as my two cases, even though at the time of the operation no opening was seen in the appendix.

Cystic appendix or so-called mucocele of the appendix is not a rare finding. It is one stage in the changes taking place in the appendix which may ultimately lead to pseudomyxoma peritonei; for of course, while an ovarian tumor may cause pseudomyxoma peritonei merely by bursting, the appendix has to be prepared for undisturbed production of mucus by several previous pathological stages by which it is shut off from the cæcum. The reports in the literature are quite uniform as to the complete shutting off of the cystic part of the appendix from the cæcum. The asepsis of the appendiceal discharge must be safe-

Fig. 1. Papillary tumor almost filling lumen of appendix (Case 1).

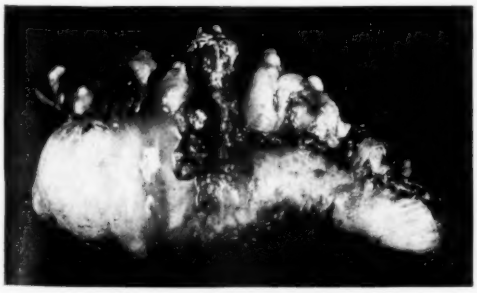

Fig. 2. Appendix of Case 2. The appendix is club shaped. On its free border are masses of pseudomyxoma. The most prominent elevation is the seat of the diverticulum.

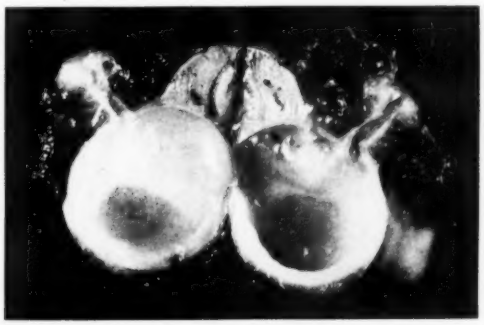

Fig. 3. Cross section of appendix of Case 2. The lumen of the appendix is widely dilated. A diverticulum is seen communicating freely with the peritoneal cavity. Masses of pseudomyxoma are attached to it on the outside.

Fig. 4. Papillæ with high cylindrical epithelium in the dilated lumen of the appendix of Case 2.

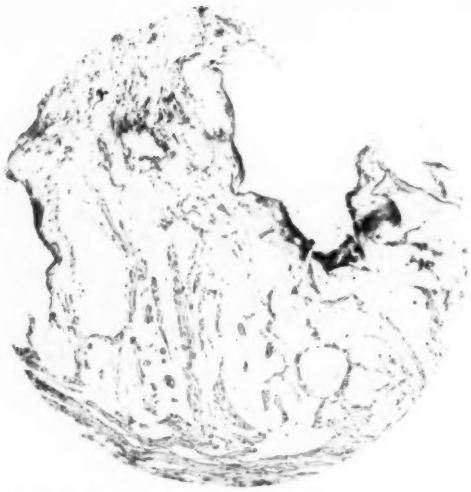

Fig. 5. Microscopic section of the diverticulum of the appendix of Case 2. This section shows the microscopic appearance of the pseudomyxomatous masses on the outside of the appendix. Fine strands of connective tissue and capillaries are seen imbedded in pseudomyxomatous material. No epithelium is seen either along the lumen of the diverticulum or on the pseudomyxomatous masses.

guarded before the peritoneum can tolerate the product of the ruptured appendix. In one case on record (Honecker's Case 1) the distal end of the appendix contained a fæcal concretion, but the discharge from the appendiceal perforation was mucus, so that even the fæcal concretion in this case must have become aseptic.

The possibility of alternating rupture and closure of ovarian tumors has to be considered in the cases of pseudomyxoma peritonei in which no perforation of the tumor is visible, as for instance in Werth's own case in which he states that no perforation was visible, though he thinks it may have been overlooked. In the light of present day knowledge the possibility of his case having been an appendiceal case can not be denied.

The opening in the ovarian tumor of my second case was examined microscopically on this account. Since the epithelium of this pseudomucinous kystoma is in very active growth it could be expected that a rupture opening of long standing would be lined with epithelium all around. Such epithelial lining would tend to keep the rupture open permanently and allow continuous discharge of mucus into the peritoneal cavity. But the microscopic examination of the edge of the opening in the ovarian tumor of the second case shows no such complete lining with epithelium. On the inside of the cyst the epithelium stops at a short distance from the hole itself, becoming gradually flatter until it ultimately is lost entirely and the edge of the opening itself consists of connective tissue only (Fig. 7). From this it may be concluded that healing of the rupture of this part of the ovarian tumor could take place at least temporarily. Such ruptures healed over by delicate cicatricial structures may be the areas at which ovarian tumors rupture at the time of operation even under gentle handling.

SOURCE OF MUCUS IN ABDOMINAL CAVITY

Given the perforation of the appendiceal or ovarian cyst with consequent escape of contents into the peritoneal cavity the reaction of the peritoneum has given rise to a great amount of discussion.

The idea prevailed for a time that the pseudomyxoma peritonei was a myxomatous tumor of the peritoneum itself produced by a kind of infection of the peritoneum by the mucus in-

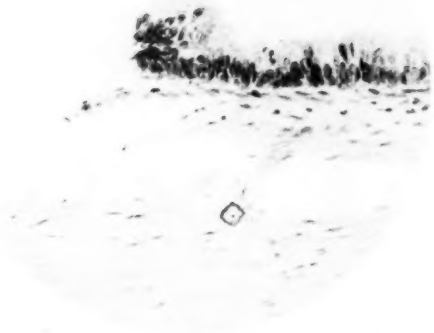

Fig. 6. The epithelium of the appendiceal cyst terminates in a ridge before reaching the rupture opening (Case 2).

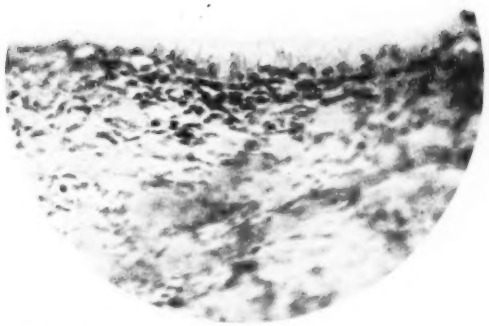

Fig. 7. Edge of rupture opening in ovarian cyst (Case 2) consisting of connective tissue only.

vading it and causing it to produce mucus on its part independently. This hypothesis is abandoned, first, because there is no warrant for any such process anywhere else, and second, because the examination of the relation of the peritoneal epithelium to the masses of colloid in the peritoneal cavity has proven beyond dispute that the pseudomyxoma masses are superimposed on the peritoneal epithelium. It is true that the peritoneal epithelium may be lost here and there, as under adhesions of inflammatory origin. It is also true that the peritoneal epithelium may be found in places on top of the pseudomyxomatous masses. But it is easy to demonstrate that there are always more or less extensive stretches of serosal epithelium well preserved under the masses of mucus.

In my Case 1 the normal atrophic ovary of the right side was covered with colloid material which could not be detached easily. But the surface epithelium of the ovary could be seen in many areas perfectly distinct under the mucus, though in other places the mucus was in direct contact with the cortical layer of the ovary (Fig. 8). The cortical layer itself showed no myxomatous formation whatever. Also the surface epithelium of the ovary could be seen creeping up the underside of the mucus wherever well preserved surface epithelium had maintained a hold on the cortical layer. The ovarian epithelium in this respect behaves exactly like the epithelium of the peritoneum otherwise.

The reaction of the serosal epithelium is the same as we are wont to see it in the presence of inflammatory irritation, be it of bacterial or foreign body origin.

Numerous cases are reported in which after removal of the original ruptured ovarian tumor or appendix the pseudomyxoma peritonei was not arrested, but continued with unabated energy to produce more colloid material in the peritoneal cavity as well as in its wall until the final destruction of the individual. In the days before Fraenkel taught the connection of the appendix with pseudomyxoma peritonei, it is certain that operators removed ovarian tumors without looking for the appendix and may have left behind an appendix affected in the way the two cases reported here were affected. As late as 1913 Rathe gives a suggestive report of this kind. His patient was first operated on in 1909 for cystic ovarian tumors, one of which had ruptured at removal. At this time free jelly was found in the abdominal cavity. Nothing at that time was noticed concerning the

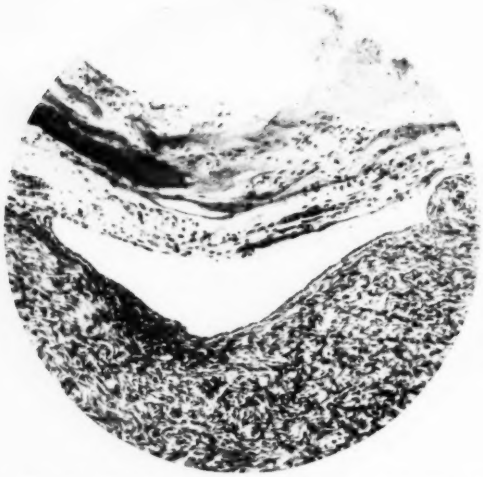

Fig. 8. Healthy ovary of Case 1, showing normal germinal epithelium creeping over the underside of the pseudomyxoma masses attached to the ovary.

Fig. 9. Nodule in the umbilicus of Case 1, showing pseudomyxomatous masses in nests without any epithelium.

appendix. In March, 1912, a gelatinous tumor of the peritoneal side of the abdominal wall was extirpated and nothing else was found in the peritoneal cavity. In October of the same year another tumor in the abdomen was found. At operation multiple tumors were found on the right broad ligament, on the bladder, on the small intestine, and now a sac of the appendix was found and removed which was full of colloid material. It showed no perforation but its wall contained tumor masses.

On the other hand there are cases in which the appendix, the source of the pseudomyxoma peritonei was removed and the pseudomyxoma peritonei reappeared afterwards and terminated the life of the patient (Case 3, Michaelson).

It is clear, therefore, that once the pseudomyxoma peritonei has become established it may continue to grow afterward independently. The authors are well agreed that these cases are by no means to be confounded with malignant growths as the findings in the metastases do not support a diagnosis of carcinoma in any way. To explain the reappearance or continuation of the pseudomyxoma peritonei after removal of the original tumor, various theories have been offered.

In the vast majority of cases it is decidedly difficult to find any epithelial elements in the colloid masses. Investigators who have persistently looked for such epithelial masses have had very meager results. In some cases originating in ruptured ovarian pseudomucinous cysts, small quantities of epithelium arranged in the same way as the epithelium of the original ovarian cysts have been found, for instance by Fraenkel in his Case 2 of his 1912 publication. In some cases originating in ruptured appendiceal cysts, very small quantities of epithelium arranged in ribbons have been observed, for instance by Comolle (ribbon in a spleen metastasis) and Hueter and Merkel, who found epithelium in tumor masses at a distance from the appendix. But in the majority of cases no such epithelial sources of possible continued growth of pseudomyxoma peritonei could be discovered. Naturally it is impossible to examine the entire peritoneum of a case of pseudomyxoma peritonei. At any rate it is quite clear that epithelium of any kind is a very occasional observation in the masses of mucus superimposed on the peritoneum in these cases, with one exception. This exception is to be made in favor of the peritoneal epithelium itself which in practically all cases

is observed in more or less extensive areas under the superimposed mucus as is described above for the ovary in my first case.

The question now arises: Is it possible for the peritoneal epithelium to assume the function of producing mucus? The recent discussions of tumors of the type of uterine adenomyomata have shown a tendency to attribute the source of these tumors to serosal epithelium. At present neither reports in the literature nor my own findings in my two cases have shown evidence of any extensive production of mucus from the serosal epithelium.

Lauche describes quite extensive tumors of the type of uterine adenomyoma (3 cases of his own and 21 from the literature) located in the umbilicus and giving evidence of menstrual function. But the little tumor in the umbilicus of my first case of 1907 shows no adenomyomatous structure. On the contrary it consists of masses of mucus without any epithelium that I could find. The mucus (Fig. 9) is arranged in nests in more or less parallel layers in the same way in which we see the mucus come out of the epithelial cells in the ovarian pseudomucinous kystoma or in the papillomatous appendix of the same case. There is tissue reaction in the shape of infiltration with round cells, scant in the mucus, more extensive in the surrounding tissue. Numerous plasma cells are seen at the edge of the masses of mucus (Fig. 10). But at no point could I demonstrate any epithelium.

It is possible that epithelial cells were originally implanted in this tissue, were crowded out, and disappeared entirely after having given rise to the mucus. But it is also possible that this mucus was crowded into the connective tissue interstices from the full peritoneal cavity without any epithelium accompanying it and simply became encapsulated. The nests of mucus reach neither the skin surface nor are they in direct contact with the peritoneal epithelium.

Similar observations have been made in the hilus of the spleen and in the hilus of the liver (Michaelson's Case 3).

Nevertheless with our present understanding of pathology we have to assume that the continued growth of pseudomyxoma peritonei after operation must be due to epithelium implanted, proliferating, and secreting.

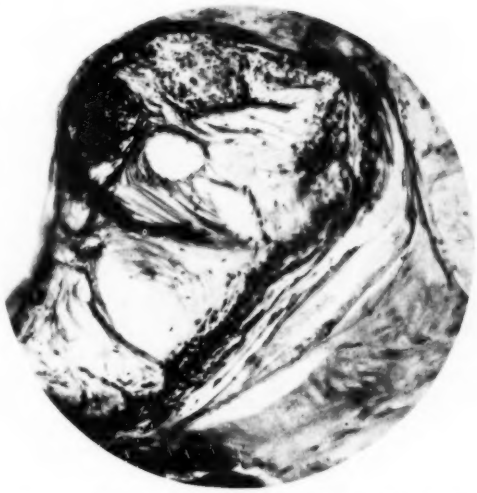

Fig. 10. One of the pseudomyxomatous nodules in the umbilicus of Case 1 under high power showing parallel arrangement of strands of pseudomyxomatous material and round cell infiltration. No epithelium is to be seen.

METASTASIS

In cases like the two reported here, two sources of the mucus pour their contents into the abdomen, the ruptured ovarian tumor and the ruptured appendix. But in the masses of mucus found in the peritoneal cavity and on the intra-abdominal organs, the gelatinous material looks alike everywhere. The gelatinous contents of the ovarian tumors in my cases were rather thicker than those of the appendix, but in the peritoneal cavity the masses appeared much the same everywhere.

As mentioned above the structural resemblance between the papillomatous tumor in the appendix and the papillary elevations in the pseudomucinous kystomata of the ovary is such that they are practically identical. Is it possible that the appendiceal papillomata were metastases of the ovarian tumor? Or on the other hand, is the ovarian tumor a metastasis of the appendiceal papilloma?

This suggestion was raised as early as 1913 by Bondy in a discussion of Rathe's case.

The possibility of the appendiceal cases being metastatic from the ovarian tumors is of

course excluded at once and completely by the numerous observations of pseudomyxoma peritonei in man.

The reverse possibility of the ovarian tumors being metastatic from the appendix is excluded by the fact that the pseudomucinous kystomata in these cases present an absolutely identical structure with the ordinary pseudomucinous kystomata found in hundreds of cases with no question of disease of the appendix from which they may have arisen.

It is remarkable indeed how frequently coexistence of a pseudomucinous kystoma of the ovary and cysts of the appendix of various natures is mentioned in the literature of pseudomyxoma peritonei. Aside from Pfannenstiel's suggestion that the organism may have excreted in the appendix pseudomucine absorbed from the peritoneal cavity, nobody has ventured to assume any connection of cause and effect between the two.

CHEMISTRY OF THE COLLOID MATERIAL

The contents of the tumors are generally described as pseudomucine, while the contents of the cystic appendix have generally been called mucine. Lewis, in 1914, published some chemical investigation of a very remarkable instance of pseudomyxoma peritonei. In her case the patient had bilateral ovarian tumors removed 22 years before she came to operation with a pseudomyxoma peritonei. Unfortunately the paper mentions nothing whatever about the condition of the appendix in this case. We are therefore in the dark as to whether the chemical researches refer to gelatinous material from an ovarian or an appendiceal source.

VARYING MALIGNANCY

It is claimed by some authors that the pseudomyxoma peritonei originating in ruptured ovarian tumors is much more liable to continue even after careful operation and to kill, while the pseudomyxoma peritonei following ruptured appendiceal cyst is supposed to be less fatal. However the literature contains instances of recurrence and fatal outcome as well as apparently complete cure by operation, whichever the original source of the pseudomyxoma may have been.

DIRECTION OF FUTURE OBSERVATIONS

A question of some interest arises here. Why is it that no cases of pseudomyxoma have ever been observed originating in the gall bladder or the fallopian tubes? The gall bladder fulfills the theoretical conditions for such an occurrence very well and papillomata of the tubes are not very rare.

TREATMENT

The operative treatment of pseudomyxoma peritonei consists of two parts, the removal of the original source and the treatment of the pseudomyxoma.

The removal of ovarian tumors in the presence of pseudomyxoma is indicated whether they are ruptured or not and since many of these tumors are more or less intraligamentary the removal of the uterus with them may become necessary. But no case of pseudomyxoma peritonei in the presence of ovarian tumors should be considered completely treated without a careful investigation of the appendix. Whether the appendix is much enlarged or not, whether it forms a ruptured or closed cyst, whether it shows diverticula, ruptured or unruptured, or not, it should certainly be removed. This removal may even necessitate the resection of the cæcum, as Hartmann did in one case which at the operation he considered a malignant tumor of the cæcum. If the appendix is so imbedded in the gelatinous material that it can not be isolated, the resection of the cæcum may on that account become indicated.

If the pseudomyxoma peritonei is accompanied by the formation of nodules in the umbilicus, as in our first case, that nodule should be removed. If omentum is the seat of extensive gelatinous infiltration or separate tumors it had best be removed.

The treatment of the gelatinous masses on the parietal and visceral peritoneum is often difficult. Washing out the peritoneal cavity is not usually sufficient. In Bailey's case, for instance, the gelatinous masses in the peritoneal cavity were washed out at the operation, but when the same patient was operated on ten days later for an inguinal hernia, the sac was found filled with gelatinous material. Gentle wiping off of the gelatinous masses is

generally mentioned, but almost always greater or smaller quantities of the jelly remained behind in recesses of the peritoneal cavity or firmly attached to the organs. Since the anatomical examination of the organs to which the jelly was attached has shown so universally extensive loss of peritoneal epithelium under the jelly, complete removal of the jelly would of necessity leave great raw areas and would thereby lead to the same extensive adhesions which are the source of so many dangerous conditions in pseudomyxoma peritonei.

There is no question about the advisability of removing isolated outstanding pseudomyxomatous tumors, but there are limitations to this step as the tumors often are so numerous that their complete removal is impossible.

In the early years of our acquaintance with pseudomyxoma peritonei drainage was instituted in order to allow the escape of the masses which could not be completely removed at the operation. These patients practically all died. In 1903 Goette reports that of 18 patients operated upon only 10 survived. At present the mortality is extremely small, but drainage is no longer favored.

The results of the operations have been good at times even though the entire masses of gelatine could not be removed. Operations for pseudomyxoma have been repeated in a number of cases and recoveries for longer or shorter periods have taken place after such repeated operations. In 1901 Fraenkel mentions this fact and explains it as a consequence of implanted epithelium dying off by and by.

The longest recorded time of cure by operation is that of my first case. The patient is now alive and well seventeen years after her operation for ruptured ovarian pseudomucinous kystoma and ruptured appendiceal cyst with papilloma. Her physicians, Drs. C. G. Lyda and A. L. Cambre, reported in April, 1924, that she was as well as her advanced years could allow one to expect. In my second case, the patient was operated upon in 1923 and is well at present without any signs of recurrence.

CONCLUSIONS

1. Pseudomyxoma peritonei is a secondary condition due to the escape of gelatinous material from a primary tumor. This tumor arises in the ovaries or in the appendix or both or rarely in other organs.

2. The ovarian tumors are always pseudomucinous kystomata in their entirety or at least partially.

3. The appendices from which pseudomyxoma peritonei starts are always more or less cystic, often show diverticula, and may contain papillomatous tumors.

4. The operative treatment is successful in proportion to the completeness of removal of the original tumors and the pseudomyxoma peritonei.

5. Every case of pseudomyxoma peritonei, especially in the female, requires investigation of the appendix and its removal.

6. The chemistry of the gelatinous masses deserves further study with proper attention to the sources of the colloid material.

7. The coexistence of ovarian tumor with appendiceal cyst in pseudomyxoma peritonei is a frequent finding. There is at present no evidence of anything more than accidental coexistence of the two conditions.

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INFLAMMATORY CARCINOMA OF THE BREAST

A Report of Twenty-Eight Cases from the Breast Clinic of the Memorial Hospital

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INFLAMMATORY carcinoma of the female breast presents such unusual clinical manifestations that they are often misinterpreted by the physician who is first consulted. The object of this paper is to give a clear description of "inflammatory carcinoma of the breast," in order that this unusual phase of carcinoma of the mammary gland may be better recognized by physicians generally and by surgeons and radiologists particularly. In addition, certain biochemical, bacteriological and pathological aspects of this interesting condition are also presented.

We have seen a considerable number of patients suffering from this type of mammary carcinoma in which the true significance of the inflammatory phenomena was not apparent. Many of these cases have been referred to the Memorial Hospital in the belief that the inflammatory process was some unusual type of infection or that the condition of the skin had been induced by radiation. Several times we have presented cases of inflammatory carcinoma before surgical societies, but apparently have failed to convince our audiences that these inflammatory symptoms were truly cancerous in nature.

Examples of this unusual type of mammary cancer have been described by numerous observers, but with variations in terminology suggesting the uncertainty which exists concerning the true nature of this process. As far back as 1814, Bell appreciated the gravity of these inflammatory symptoms. In discussing carcinoma of the breast he said: "When a purple color is on the skin over the tumor accompanied by shooting pains, it is a very unpropitious beginning." Klotz, in 1869, in an inaugural thesis, wrote about this phase of mammary carcinoma occurring during pregnancy and the puerperium. Volkmann, in 1875, described it as "mastitis carcinomatosa." Schumann and Learnmouth have called it "carcinoma mastitoides" and "acute mammary carcinoma," while Rodman and Leitch apply the term, "acute carcinoma of the breast." Other authors have described the condition as lactation cancer, acute medullary carcinoma, acute encephaloid carcinoma, inflamed cancer, acute brawny cancer and acute scirrhous carcinoma. Lardennois and Moure, impressed with certain striking pathological features, considered it a lymphocytoma of the breast. All observers have focused their attention upon the pathology of the breast tumor itself, but have failed to recognize the signficance of the erysipelatous involvement of the skin. Billroth, in 1871, described a case of acute cancer of the breast, and Rodman in his treatise on "Diseases of the Breast" reported four cases of Delbet's, one of Schmidt's and one of Klotz's. Bryant, in a scholarly article in Wood's *Medical and Surgical Monographs* for 1889, recognized this condition and cited his observations on several cases. Shield also recognized this form of cancer of the breast.

From time to time Gross, Rodman, Bloodgood, and others have contributed to the subject. Thus far the most extensive case reports and the best studies of the clinical and pathological aspects of this condition have been given by Schumann who collected 11 cases from the literature. His report also included one case of his own. The present paper represents a study and analysis of 28 cases, 25 of which were seen in the breast clinic of the Memorial Hospital. We are permitted to include 3 additional cases through the courtesy of Dr. Charles H. Peck, Dr. W. S. Stone, and Dr. Bradley Coley.

CLINICAL CHARACTERISTICS

This disease is fortunately rare, representing but 1.3 per cent of all cases of mammary cancer. It is often fulminating and may result fatally in a short time in spite of the most

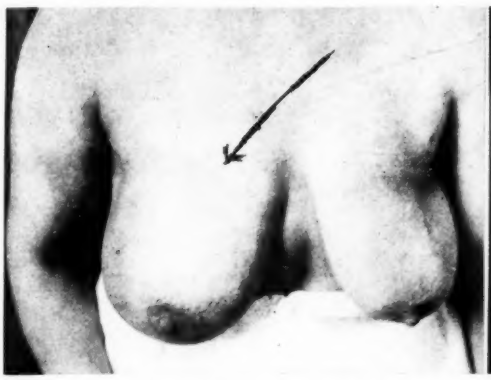

Fig. 1. Case 1. H. E. Primary operable inflammatory carcinoma, right breast, before operation.

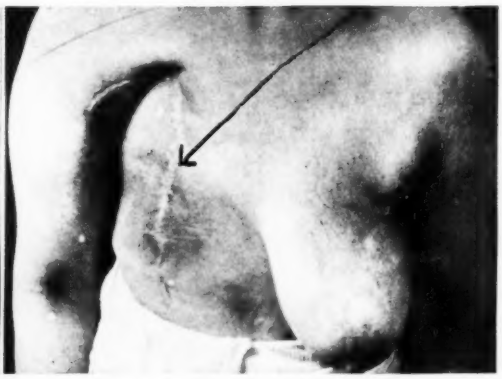

Fig. 2. Case 1. H. E. Showing recurrence of inflammatory carcinoma 2 months after radical mastotomy.

intelligent therapeutic efforts to control it. Inflammatory carcinoma may occur during pregnancy or the puerperium, when its course is rapid, but we have never observed it under these conditions.

Without subjective symptoms other than heaviness and slight burning sensation, the breast of the affected side usually increases in size. This enlargement is more often diffuse, but in some instances a rather ill-defined tumor may be mapped out, which is often soft in consistency and never of stony hardness. Almost without exception the lesion has occurred in cases with pendulous breasts and in 50 per cent of these cases lactation has never occurred.

The rate of growth is startling in its rapidity, and often the tumor fills the entire breast in a few weeks. Shortly after the beginning of symptoms, a careful physical examination will reveal certain inflammatory manifestations in and about the involved breast. The overlying skin is reddened and brawny, and this blush may extend far beyond the normal limits of the mammary gland. Upon palpation the skin is hot, and not infrequently slight tenderness is elicited. Both breasts may be involved almost simultaneously or in rapid succession. When seen early, nipple retraction may be absent; but later the nipple is definitely retracted and sometimes œdematous. The axillary nodes of the corresponding side become involved early, increase rapidly in size, and are unusually bulky. The supraclavicular nodes of the same side are palpable early and in one of the cases the first inflammatory symptom appeared above the clavicle, with brawny underlying induration. Later, nodes in the opposite axilla become involved and the opposite breast may be invaded by the disease.

As the disease progresses the skin becomes deep red or reddish-purple and to the touch is brawny and infiltrated. The inflamed area presents a distinct raised periphery after the fashion of erysipelas. The infiltration is so marked that the examiner, with his eyes closed, in passing his hand over the skin can distinguish readily the sharp contrast between normal and affected tissue. The redness may extend far beyond the normal confines of the breast, in some instances reaching from the sternal region in front, completely around one-half of the chest to the midline behind, or extending downward over the upper portion of the abdominal wall. Occasionally the skin over the opposite breast is likewise red, tender, and shows increased surface temperature. As a rule there is no well-marked elevation in temperature but some of the cases have shown an afternoon rise as high as 100 degrees F.

There are no constant findings in the microscopical examination of the bloods of the cases studied. Some cases show a slight leucocytosis (as high as 14,400 white blood cells)

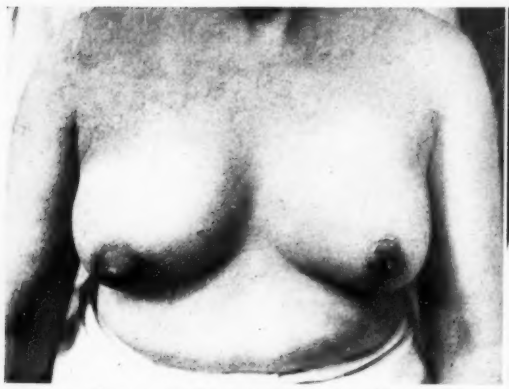

Fig. 3. Case 3. C. W. Showing early evidence of inflammatory carcinoma, right breast.

Fig. 4. Case 4. D. V. Primary inoperable inflammatory carcinoma, right breast.

and in the differential count an occasional increase in small mononuclear cells is noted. No eosinophilia is present.

Late in the course, minute areas of ulceration are occasionally noticed, but in no instance did the skin overlying the breast tissue break down *en masse*.

As a rule, cases seen early show no demonstrable pulmonary metastases, but once demonstrated in a chest plate, they are rapidly progressive.

The patients remain well nourished until late in the course, cachexia appearing only in the terminal stages. They die from systemic metastases with certain evidences of toxæmia. The inflammatory symptoms of the disease persist until the end.

We believe, therefore, that the uniform and unusual clinical behavior of these inflammatory cases justifies their inclusion in a single group.

TIME OF APPEARANCE OF INFLAMMATORY SYMPTOMS

Inflammatory symptoms were well established at the time of admission to the clinic in all but two of the cases. In many instances it was impossible to ascertain the exact time of appearance of the inflammatory signs. In several of our primary cases seen 4 to 5 weeks up to 3 months after the beginning of any symptom, the inflammatory characteristics of the disease were very pronounced. Therefore, we believe that in the majority of cases the inflammatory type of mammary cancer can be properly recognized at the very outset. Occasionally certain cases in the breast clinic, which have been under observation for a considerable period of time, have developed late in the course of the disease skin involvement closely simulating inflammatory carcinoma. With our present knowledge, it seems unwise to include cases of this sort under the heading of inflammatory carcinoma, although it is difficult to determine the exact relationship of these cases to the ones under report.

AGE

A considerable number of the patients are young women, in our series, 10, or 35.79 per cent, being 39 years or under. The youngest patient was 24, the oldest 62, and the average for the entire group was 44.6 years.

TRAUMA

In only 2 of the cases was there any definite history of trauma to the breast. Hence, the inflammatory phase cannot be interpreted as in any sense traumatic in origin.

PREVIOUS LACTATION

In 14, or 50 per cent, the disease was present in breasts which had previously lactated. Therefore, prior lactation seems to have no special influence in the development of inflammatory carcinoma. In no instance was the disease observed during pregnancy

Fig. 5. Case 4. E. E. Large vein or lymph vessel in the subcutaneous fat tissue which contains a large tumor cell mass.

Fig. 6. Case 9. R. L. Primary inoperable carcinoma, left breast. Shows beginning of inflammatory symptoms over left supraclavicular region.

or the puerperium, but Delbet reported one case occurring during pregnancy, one during lactation, and two cases irrespective of either condition. Case 10 in our own series, became pregnant one year and four months after admission, and a therapeutic abortion was done immediately.

DIFFERENTIAL DIAGNOSIS

In establishing a diagnosis, the following diseases must be distinguished from inflammatory carcinoma.

1. *Abscess of the breast.* Inflammatory carcinoma of the breast, in its early phases, is frequently mistaken for an acute suppurative process in the mammary gland. In several instances in this series, patients referred to the breast clinic have been explored by surgeons elsewhere expecting to find an abscess. The real nature of the process was then revealed. An ill-defined tumor in the breast, absence of localized tenderness, no considerable elevation of temperature and a white blood cell count which is normal or slightly increased should rule out a suppurative lesion.

2. *Erysipelas.* In this region erysipelas is rather uncommon. The disease is quite acute and prostration is marked. As in all febrile conditions, it is ushered in by a short period of malaise and headache, followed by rigor, high fever, and the appearance of the rash. The lesion is vivid red, disappears on pressure, and is not particularly sensitive, and soon vesicles and bullæ form containing serum. There is a marked leucocytosis. The disease within 48 hours progresses rapidly. The acute history, with the constitutional reaction and dramatic spread of the lesion, together with the decided increase in leucocyte count is sufficient to distinguish erysipelas from inflammatory carcinoma.

3. *Radiation changes.* Several of the patients were referred to the hospital in the belief that exposures to X-radiation had caused the inflammatory phenomena. The erythema following radiation therapy usually appears in from 10 to 14 days after treatment. It is at its height for another 10 days and then gradually fades away, leaving a slightly pigmented skin, but with no permanent redness. The skin changes stop abruptly in a linear fashion corresponding to the areas of treatment. A review of the radiation treatment given and an appreciа-

Fig. 7. Case 11. R. E. Primary inoperable inflammatory carcinoma of the right breast. The skin lesion involves inner third of left breast.

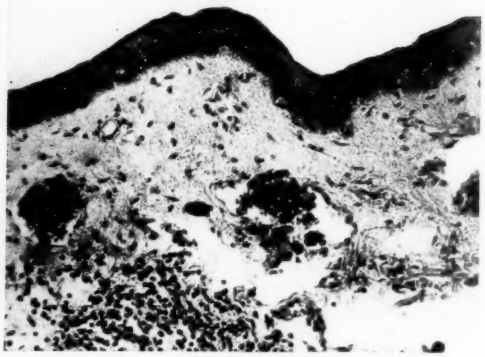

Fig. 8. Case 11. R. E. Lymphatics of derma filled with loose tumor cell masses. Marked lymphocytic infiltration of derma. Œdema from lymph stasis.

tion of the persistent or progressive character of the inflammatory symptoms in this special form of carcinoma, suffices to establish the diagnosis.

4. Tuberculosis of the breast. In this condition, the onset is less acute, and the tumor in the breast is never hard in consistency. Early in the course, redness of the overlying skin appears and later areas of softening. As the process extends the skin over the softer portions thins out and finally sinuses form which are usually multiple. Physical signs of tuberculosis elsewhere may also be demonstrated. This condition from its chronicity, may be readily distinguished from inflammatory carcinoma.

5. Ulcerating carcinoma of the breast. The inflammatory reaction so frequently found in the skin and subcutaneous tissues associated with ulcerating mammary cancer can be easily differentiated from inflammatory carcinoma. Ulcerating carcinoma of the breast is the result of a secondary invasion and destruction of the skin by the tumor with concomitant infection. In all cases in this report the history and physical examination have proven to our satisfaction that the inflammatory symptoms present were certainly not dependent upon a break in the skin or some minute ulcer. Except in the terminal stages, inflammatory carcinoma is never ulcerating. In many of our fatal cases there was no break or ulceration of the inflammatory skin at the time of death.

6. Cancer en cuirasse. This form of carcinoma of the breast usually occurs in a patient over 50 and extends over a period of years, being notable for its chronicity. In the beginning the tumor is small, discrete, and belongs to the type which Cheyne calls "atrophic scirrhus." The skin is slowly involved, becoming thickened and slightly pinkish and this condition may extend until it includes a large portion of one or both sides of the mammary and anterior chest regions. Later, small and large ulcerating areas may appear, when the inflammatory appearance of the skin becomes accentuated. Inflammatory carcinoma occurs on the average at an earlier age, is much more rapid, and the whole picture is one of an acute fulminating process.

7. Paget's disease of the nipple (dermatitis maligna). The skin lesion in Paget's disease involving the nipple, areola and surrounding skin, presents a reddened, granular surface discharging a yellow viscid fluid. At times the appearance is that of a chronic eczema with encrustations. The lesion is frequently confined to the areola alone and the nipple disappears as the disease progresses. In our series, the inflammatory symptoms never began in or about the areola. Paget's disease is unilateral while the inflammatory

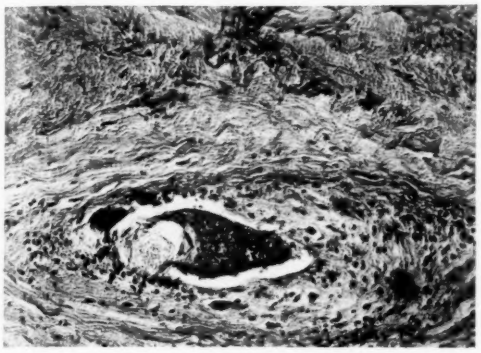

Fig. 9. Case 14. Y. S. Large artery in subcutaneous fat tissue filled with tumor cell thrombus, from mass in left breast.

Fig. 10. Case 15. M. B. Primary inoperable inflammatory carcinoma, right breast. Left breast beginning to be involved. (Black mark caused by adhesive.)

type of carcinoma is often bilateral. Further, Paget's disease usually occurs between the ages of 40 and 60 years.

8. Gumma of the breast. Adair has recently reported a case of gumma of the breast observed in this clinic. In this condition there is a reddish-bronze color of the skin directly over a circumscribed, hard tumor, which is freely movable. No other features suggest carcinoma. A careful history and a Wassermann test will differentiate this condition.

PATHOLOGY

Except in a few instances neither mastectomy nor biopsy has been done; hence we are unable to report fully the pathology of the breast tumor. In the recurrent cases few pathological reports or slides have been furnished by the hospitals in which the operation was performed, although every effort has been made to obtain them. The findings vary from comedocarcinoma, carcinoma simplex, mammary carcinoma invading dermal lymphatics, and large alveolar carcinoma to scirrhous carcinoma.

The marked variation in the pathological findings raises the questions: Is one justified in including these inflammatory carcinomata in a single group? Is it not possible that some additional factor has been added to account for the inflammatory manifestations?

In a few cases, a study of the material obtained through areas of skin invasion shows dermal lymphatics everywhere invaded by carcinoma cells. This diffuse lymphatic metastasis is the most distinctive microscopic pathological feature of this phase of mammary carcinoma. The recent report by Delbet and Herrenschmidt of a case of mammary carcinoma, which they call cancer (hæmophile) emphasizes the possibility of the spread of the disease through the blood vessels.

Ewing has pointed out that the mode of extension when the skin is invaded is by way of the subpapillary lymphatic plexus from the periductal lymphatics. Deaver and McFarland state that in acute mammary carcinoma, the lesion is characterized by a "combination of purulent infiltration and carcinomatous change in which the carcinoma cells seemed to be diffused in the puriform collection." In the pathological report of Schumann's case, the gross appearance on incision was that of a firm tumor in which small abscesses were present. The substance of the growth was firm and fibrous and of a purplish-red color. There were small isolated areas of hæmorrhage and a gradation from small necrotic spots to abscesses was observed. The contiguous skin was œdematous and indurated.

He considers the microscopical picture a complex one and reports it as follows:

"The main characteristics are those of a medullary carcinoma growing with a small amount of connective-tissue stroma, interspersed with groups of closely packed cell nests of a scirrhous type. Other fields are

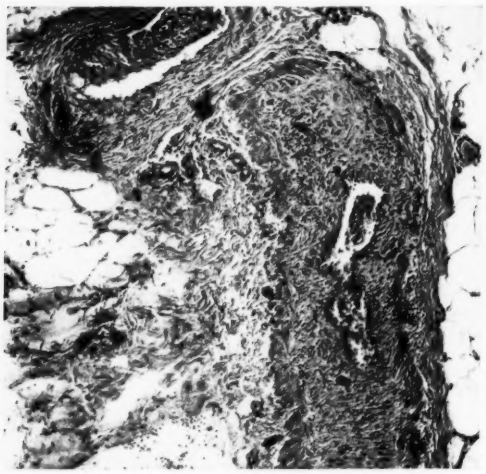

Fig. 11. Case 16. M. W. Large artery filled with tumor cell thrombus.

similar to carcinoma simplex. The important feature is the secondary inflammation set up—small abscesses being scattered throughout." He does not report on the microscopical pathology of the skin.

The pathological picture of minute abscesses throughout the breast, described by Deaver and McFarland and by Schumann in acute inflammatory carcinomata have not been seen in any cases studied in our series.

Histological structure of inflammatory carcinoma. We are indebted to Dr. James Ewing for the following report based upon a study of portions of involved skin and underlying tissue removed from Cases 11, 15, 16, and 17, the axillary mass in Case 8, and the breast tumor from Cases 1 and 14. Results of examination in Case 4 are also added.

The main skin lesion is a diffuse permeation of dermal lymphatics and in some instances of blood vessels of the derma and subcutaneous tissue.

In Case 11, many of the dermal lymphatics are distended with large tumor cells, loose or in coherent clumps and at some places adherent to the endothelium. Both lymphatics and venules are involved and in the venules the tumor cells are generally mingled with red blood cells and some lymphocytes. The tumor cells show marked degenerative changes including hydropic degeneration, swelling and hyperchromatism of nuclei, and isolated cell necrosis. About all invaded vessels there is a rich exudation of small lymphocytes.

Fig. 12. Case 18. M. F. Primary inoperable inflammatory carcinoma, left breast.

In Case 15, both the lymphatics and venules of the derma are distended with solid masses of well nourished tumor cells. In some vessels there is no blood but only tumor cells; in others the tumor cells are mingled with blood cells, while in a few the tumor cells float freely in the blood. Lymphocytic infiltration is abundant in many places but is not uniform.

In Case 16, there are loose tumor cell emboli in the large arteries of the subcutaneous fat.

From these observations it appears that the cutaneous changes in inflammatory carcinoma consist of an invasion of the dermal lymphatics and venules with tumor cells, which excite a lively venous congestion and marked lymphocytic perilymphangitis and phlebitis.

Pathology of Case 1. Gross pathology: The breast is occupied by a hard, opaque, cicatricial cancerous mass 8 by 10 centimeters, which is well circumscribed, extending from near the nipple to the deep muscular fascia. The mass exudes much yellow fluid. The deeper portions are hyperæmic. The small remainder of the breast is œdematous and fibrous. Three small axillary nodes are hard and white. The skin is slightly browned.

Microscopic examination: The tumor is a very cellular comedo-duct carcinoma of a large alveolar structure with extensive invasion of the connective tissue of the breast. The cells are hydropic. The stroma is richly infiltrated with lymphocytes and is œdematous with granular degeneration of collagen fibrils. Three nodes are completely replaced by carcinoma.

Pathology of Case 14. Gross pathology: The breast is bulky, protuberant, and firm. The skin is scaling and thickened over the entire specimen, and over 4 centimeters at the nipple is apparently invaded by carcinoma. The nipple is involved in a diffuse mass of carcinoma which is continuous below with the main tumor. The main tumor is located directly beneath the nipple and presents a firm opaque circumscribed solid mass triangular in shape, 8 centimeters across the base. Two centi-

meters of uninvolved fat tissue separate the tumor from the muscle. Axillary contents are missing.

Microscopic examination: The main tumor is a large alveolar carcinoma from which there is extensive infiltrating carcinoma with very marked fibrosis. In a few dermal lymphatics the lumen is distended with large tumor cells. The skin is much fibrosed.

Pathology of Case 4 was furnished through the courtesy of Dr. Chas. H. Peck. Examination was made by Dr. A. B. Reese, Senior Pathologist.

Macroscopic examination: The specimen consists of the entire left breast with an area of skin measuring 21 by 13½ centimeters. This includes the nipple which is not retracted. The pectoralis major muscle has been removed separately from the breast. The tumor is scattered throughout almost the entire breast. In some places it appears to be encapsulated while in others it is infiltrating. The tissue is grayish-white to pinkish-white in color; firm and elastic with hard bullet-like nodules scattered throughout it. By squeezing, a soft creamy substance is made to ooze out from various foci. The axillary contents contain numerous small nodules, the largest being about 2 by 1 centimeter. On section this is firm, white tissue similar to that seen in the breast.

The sections show glands (2), non-encapsulated tumor, and encapsulated tumor.

Microscopic examination: The tumor is composed of large masses of epithelial tissue growing in structureless fashion. The tissue is exceedingly cell-rich; in places 4 to 5 nuclei are seen overlapping each other and growing as one nucleus. The nuclei are mostly large; vary greatly in size; have nucleoli and many mitotic figures are seen. There is very little stroma. Both the encapsulated and the non-encapsulated parts of the tumor are the same. The axillary lymph nodes show metastasis.

Diagnosis: Medallary carcinoma of female mammary gland with metastasis to axillary lymph nodes.

Fig. 13. Case 26. R. F. Recurrent inflammatory carcinoma, right breast. Appearance 6 weeks after radical mastectomy.

BACTERIOLOGY

Sections of skin from Cases 15, 16, and 17, which were removed under strict aseptic condition, were studied bacteriologically by Dr. J. C. Torrey, whose findings are reported.

The material consisted of segments of tissue about 0.5 centimeters wide and 2 centimeters deep. Fatty tissue below the skin was present. The sections were sent in sealed Petri dishes and were received in good moist condition. Cultures were started at once.

Media used:

1. Aerobic cultures—ascitic agar plates—pH.7.4; blood agar plates.

2. Partial anaerobiosis — blood agar (subtilis method); semi-solid ½ agar (vitamine) plants just below the surface; glucose broth in fermentation tubes.

3. Complete anaerobiosis—deep plants in casein digest agar, vaseline cap.

Cultures were incubated at 37 degrees C. and observed for twelve days.

Results. Bacteria were not numerous in any case. No single type of possible pathogenic organism was found in all cases. The following findings are only suggestive.

Case 15. A long chain streptococcus was isolated, a few colonies appeared on two plates. This streptococcus belongs in the viridans group. It causes very slight hæmolysis like the alpha type. It does not ferment any sugar (glucose, lactose, mannit, salicin or raffinose) and is peculiar in this respect. Morphologically it suggests a pathogenic type.

Case 16. No pyogenic organisms were found. A strain of bacillus lymphophilis, which I have described as occurring constantly in Hodgkin's disease, was recovered.

Case 17. Typical staphylococcus aureus cultures were recovered from this case. These occurred in considerable numbers on one plate.

The only other reference to the bacteriology of the breast in cancer is the report of Monsarrat, whose conclusions are not convincing.

BIOCHEMICAL

The chemical composition of the blood in cancer has been studied by Theis and Stone. The non-protein nitrogen, urea nitrogen, uric acid and sugar in the blood were determined in 189 cases, 13 being patients with carcinoma of the breast. The conclusions drawn from these studies were: (1) Non-protein nitrogen and urea nitrogen are low in the blood of cancer patients. (2) Uric acid, except in cases with kidney complications and 2 cases of melanoma, is not abnormal in cancer blood. (3) Blood sugar is not increased in cancer.

PRIMARY OPERABLE INFLAMMATORY

No.	Name	Age	S M W	Lactation	Trauma	Date of first symptom	First symptom	Date of admission	Condition on admission
1	H. E. Dr. Adair No. 28763	39	M	1	No	1919	Nodule size of a pea above nipple of right breast	2-25-21	Bulky, ovoid mass above right nipple 5 by 5 by 8 cm. Blush of skin which is adherent. Tumor movable over chest wall. Right axillary nodes involved
2	I. L. Dr. Lee	43	S	0	No	Apr., 1922	Lump in upper outer quadrant of right breast	6-24-22	Tumor in right breast 6 by 8 cm. Breast reddened and œdematous. Skin fixed. Right axillary nodes involved
3	C. M. Dr. Lee	34	M	2	No	Feb., 1922	Swelling in right breast and pain (lactating)	7-10-22	Whole right breast involved in tumor process with inflammatory involvement of skin. Mass of axillary nodes fixed. No supraclavicular involvement
4	E. E. Dr. Peck	48	W	0	No	May, 1922	Small mass in left breast	Nov., 1922	Diffuse mass in upper outer quadrant of left breast. Red blush with local heat. Axillary nodes palpable. No supraclavicular involvement

PRIMARY INOPERABLE INFLAMMATORY

5	D. V. Dr. Lee No. 31812	39	M	0	No	Feb., 1923	Large tumor occupying most of right breast	Mar., 1923	Tumor of right breast occupying ⅔ of breast and measuring 6 by 5 by 3 cm. Skin red and adherent. Tumor movable on chest. Right axillary nodes involved. Right supraclavicular fulness. One node in left axilla
6	L. S. Dr. Lee No. 32528	50	M	0	Yes	Dec., 1922	Uniform enlargement of left breast with pain	Mar., 1923	Circumscribed tumor in left breast 3 by 3 cm. with skin fixation, nipple retraction. Skin reddened, supraclavicular fulness on left side. No axillary involvement
7	M. T. Dr. Lee	52	S	0	Yes (?)	—1921	Several small nodules in upper portion of left breast	Oct., 1923	Mass in upper outer quadrant of left breast. Skin inflamed and adherent. Axillary nodes quite firm in left side and one in left supraclavicular fossa. Nipple has disappeared and is replaced by a large scab
8	F. K. Dr. Lee No. 31397	36	M	3	No	Apr., 1922	Thickening in upper portion of left breast	Oct., 1922	Left breast higher than right. Diffuse thickening throughout the breast. Patchy reddening extending to the posterior axillary line. Firm axillary nodes in the left side and in the supraclavicular fossa
9	R. L. Dr. Lee No. 31644	46	W	?	No	Dec., 1921	Small lump size of pea in left supraclavicular fossa, then hardness in left breast	May, 1922	Indefinite indurated mass in outer segment of left breast which is heavier and larger than right. Peau d'orange axillary and supraclavicular nodes involved and one in right axilla

CARCINOMA OF THE BREAST

Chest plate	Path. type	Treatment	Result of treatment	Course	Duration		Total duration	Result
					before admission	after admission		
2-4-21, Neg. for pulmonary metastases. 1-11-22. Metastases present	Comedo-duct Cancer	Feb., 1921, X-ray cycle -4. Radium pack. May, 1921, Radical mastectomy. Oct., 1921, X-ray cycle. Dec., 1921, X-ray cycle	Delayed healing. Skin involvement. Left breast also involved	Rapid progression of all lesions after operation	2 yr.	1 yr., 2 mo.	3 yr., 2 mo. Died	Died.
6-24-23, Lungs showed metastases		June, 1922, H. V. X-ray. Aug., 1922, H. V. X-ray. Dec., 1922, H. V. X-ray	Regression of tumor and axillary nodes	Tumor recurred. Progressive rapid failure with metastasis to skull	2½ mo.	1 yr., 3 mo.	1 yr. 5½ mo.	Died.
7-25-22, Neg. 5-1-23, Pulmonary metastases		July, 1922, H. V. Aug., 1922, H. V. Sept., 1922, Radical mastectomy elsewhere. May, 1922, X-ray cycle	No record of regression of tumor before operation	Returned after operation with extensive cutaneous lesions and metastasis to spine and pelvis. Rapid decline	5 mo.	1 yr., 4 mo.	1 yr., 9 mo.	Died.
Nov., 1922, Neg.		Nov., 1922, Radical mastectomy (left). Jan., 1923, H. V. X-ray. Nov., 1923, Radical mastectomy (right)	Surgery disastrous	Case represents a postoperative case doing badly by radical surgery. Recurrence very extensive and case seems hopeless	6 mo.	1 yr., 3 mo.	1 yr., 9 mo. Diffuse recurrence cutaneous and to nodes.	

CARCINOMA OF THE BREAST

Mar., 1923, No evidence of pulmonary metastasis		Mar., 1923, X-ray cycle Radium needles. June, 1923, X-ray cycle	Decrease in size of tumor	Ulceration of right breast. Infiltration of skin. Tumor in left breast. Nodes in both axillæ	1 mo.	1 yr.	1 yr., 1 mo.	Doing poorly.
		Mar., 1923, X-ray cycle. May, 1923, X-ray cycle. Oct. and Dec., 1923, X-ray cycle. Radium needles	Marked decrease in size of breast. No pain, less nipple retraction and fixation of skin	Satisfactory regression. Gain in weight. Slight increase in size of tumor	3 mo.	11 mo.	1 yr., 2 mo.	Doing well.
Oct., 1923, Does not show pulmonary metastasis		Nov., 1923, X-ray cycle. Failed to keep appointments for treatment	Increase in size of breast and increase in ulceration	Chemical removal advised but refused	2 yr.	4 mo.	2 yr., 4 mo.	Doing poorly.
Oct., 1922, Neg. for metastasis June, 1923, Some peribronchial infiltration, but no definite evidence of metastasis. Dec., 1923, neg.	No. 6293 Carcinoma simplex in left axillary node	Oct., 1922, X-ray cycle. Dec., 1922, X-ray cycle. Feb., 1923, Radium needles, X-ray cycle. June, 1923, X-ray. Dec., 1923, X-ray cycle	Considerable diminution in size of breast. Axillary and supraclavicular nodes smaller	Metastatic nodules in skin over left breast. Skin involvement has extended over left supraclavicular fossa and left lateral chest wall	6 mo.	1 yr., 4 mo.	1 yr., 10 mo.	Local condition fair. General condition good.
June, 1923 Metastasis present in chest plate		May, 1922, X-ray cycle Feb., 1923, X-ray cycle. Radium needles. Mar. and June, 1923, X-ray cycle	Regression in mass in left breast. (Note 7-24-22 Mass cannot be palpated. Mastitis?)	Left breast became infiltrated with extension to neck and nodes extending from clavicle to mastoid, eye, face and arm became œdematous —marked dyspnœa. Death	6 mo.	1 yr., 1 mo.	1 yr., 7 mo.	Died.

PRIMARY INOPERABLE INFLAMMATORY

No.	Name	Age	S M W	Lactation	Trauma	Date of first symptom	First symptom	Date of admission	Condition on admission
10	C. W. Dr. Lee No. 32606	30	M	2	Yes (?)	June, 1920	Lump size of pea in outer quadrant of right breast	June, 1922	Right breast large and heavy with slight nipple retraction. Pig-skinning near areola below which there is a discoid mass 2 ½ by 1 cm. Hard nodes from tail of breast to axilla. Fulness in infraclavicular fossa and questionable nodes in supraclavicular fossa
11	R. E. Dr. Lee No. 28824	31	M	1	No (Aug., 1923 abscess of right breast incised)	June, 1920	Lump the size of a bean in the scar. (Received antiluetic treatment for 1 year)	Mar., 1921	Skin lesion involving inner third of left breast. All of right breast to clavicle and posterior scapular line. Both breasts heavy, full and indurated. Both axillæ show metastatic nodes
12	A. P. Dr. Lee	34	W	0	No	March, 1922	Lump the size of an olive in the right breast	June, 1922	Right breast large and hard throughout. Multiple nodules and redness in skin. Breast movable. Large node in right axilla and small one in right supraclavicular region
13	A. W. Dr. Lee	44	M	6	No	April, 1923	Noticed left breast was hard and nipple was retracted	Nov., 1923	Left breast large, reddened and hot. No tenderness. Surrounding skin pink. Definite thickening in upper middle segment, 3½ cm. in diameter. Slightly adherent to skin. Large nodes in axilla and one supraclavicular in left side
14	Y. S. Dr. Lee No. 31286	50	M	6	No	March, 1922	Mass in left breast	April, 1922	Left breast is twice the size of right and is reddened, hot, and tender. Impression that whole breast is involved in carcinoma. Large mass of nodes in right axilla and several in left side. No supraclavicular involvement
15	M. B. Dr. Lee No. 39378	56	S	0	No	Nov., 1923	Thickening in right breast	Jan., 1924	Whole right breast occupied by a diffuse mass and the skin is hot, purplish red in color. Color sharply defined. Left breast is pink. Hard nodes in each axilla. No supraclavicular involvement
16	M. W. Dr. Lee	62	M	0	No	Oct., 1923	Lump in lower inner quadrant of left breast size of walnut. Two months later skin became red	Jan., 1924	Left breast markedly reddened and occupied by ill-defined tumor. Nipple retracted. Blush extends to posterior axillary line. Left axilla extensively involved. No supraclavicular involvement
17	M. H. Dr. Lee No. 39415	49	M	3	No	Aug., 1923	Small in upper portion of right breast	Jan., 1924	Right breast enlarged and firm with wide area of reddening and infiltration of skin extending to scapula and over on the left breast and right arm. Large nodes in each axilla and right supraclavicular fossa
18	M. F. Dr. B. L. Coley	46	M	4	No	April, 1921	Nodule in left breast and axilla	Mar., 1922	Whole left breast markedly reddened and occupied by an ill-defined tumor. Skin thickened, small telangiectases present. Breast movable. Supraclavicular nodes left side involved. Redness extends up over left clavicle. Slight blush over inner aspect of right breast

CARCINOMA OF THE BREAST—Continued

Chest plate	Path. type	Treatment	Result of treatment	Course	Duration		Total duration	Result
					before admission	after admission		
June, 1922, Sept., 1923, Chest plates neg. for metastasis		June, 1922, X-ray cycle. Aug., 1922, X-ray. Oct., 1922, H.V. Dec., 1922, H. V. Oct., 1923, H. V.	Excellent regression. No tumor can be palpated. Small node in right axilla	Patient showed excellent regression. Therapeutic abortion Oct., 1922, on account of breast condition	2 yr.	1 yr., 8 mo.	2 yr., 8 mo.	2 yr., 8 mo. Doing well.
March, 1921 Chest plate neg. June, 1921 Plate positive for metastasis	No. 3878 Mammary carcinoma invading lymphatics of the derma	Mar., 1921, X-ray cycle. June, 1921, X-ray cycle. Mar. and April, 1922, H. V. July, 1922, H. V. Aug., 1922, H. V.	Most of superficial red infiltration has disappeared. Nodes present	By Nov. most of the lesions had disappeared. Antiluetic treatment continued. Showed signs of abdominal metastasis Aug., 1922. Breast condition excellent. Died Sept., 1922	9 mo.	1 yr., 6 mo.	2 yr., 3 mo.	Died.
June, 1922, Plate of lungs shows evidence of metastasis		June, 1922, X-ray cycle. July, 1922, H.V. 2	No regression	Rapid failure. Death Jan., 1923	3 mo.	7 mo.	10 mo.	Died.
Dec., 1923, No evidence of metastasis		Dec., 1923, X-ray cycle	Too early to record any result		7 mo.	3 mo.	10 mo.	Too early to record any results.
May, 1922 Chest plate neg.	No. 6158 Alveolar carcinoma with extensive infiltration. Dermal lymphatic filled with large tumor cells	April, June, Aug., Oct., 1922, X-ray cycles. Nov., 1922, mastectomy, Dec., 1922, Radium needles right breast	July, 1922, Left breast smaller and less reddened. Gain in weight	Did fairly well for several months. Dec., 1922, right breast involved. Metastasis to lumbar spine. Supraclavicular nodes involved. Died June, 1923	2 mo.	1 yr., 2 mo.	1 yr., 4 mo.	Died.
Jan., 1924, Chest plate neg.	No. 7943 Skin shows extensive invasion of subdermal lymphatics. Blood vessels filled with masses of cancer cells	Jan., 1924, H. V.	Too early to record any result		4 mo.	2 mo.	6 mo.	Too early to record any results.
Jan., 1924, Enlarged nodes in right hilum	Loose clump of cancer cells in larger arteries and lymphatics of skin	Jan., 1924, X-ray cycle	Too early to record any result		4 mo.	2 mo.	6 mo.	Too early to record any results.
		None		Disease too far advanced to treat	6 mo.	2 mo.	8 mo.	Disease too far advanced to treat.
March, 1922 Chest plate shows evidence of metastasis		Sept., 1921, Radium elsewhere	Disease advanced rapidly. Too far advanced for further therapy	Rapid decline. Death June, 1922	11 mo.	3 mo.		Died.

RECURRENT INFLAMMATORY

No.	Name	Age	S M W	Lactation	Trauma	Date of first symptom	First symptom	Date of admission	Treatment before admission	Condition on admission
19	M. B. Dr. Lee No. 31082	56	M	0	No	Oct., 1921	Tumor upper inner quadrant of left breast	June, 1922	Oct., 1921, Radical amputation of left breast. 4 X-ray treatments. Skin recurrence with local excision Apr., 1922	Area of diffuse redness 10 by 5 cm. about scar. Thickening in posterior axillary line at drainage site. No axillary nodes. Node above inner aspect of left clavicle
20	E. S. Dr. Lee	47	W	1	No	Oct., 1921	Growth in right axilla which drew the breast to right side	Oct., 1922	Radical amputation of right breast July, 1922	Right breast removed. No evidence of recurrence except for skin. Right supraclavicular space thickened
21	A. H. Dr. Lee No. 32751	57	S	0	No	June, 1921	Mass in upper middle section of left breast size of marble	Dec., 1923	Radical amputation of both breasts April, 1922	Diffuse reddened induration with nodules over the entire front of chest. Skin reddened
22	L. G. Dr. Lee	24	S	0	No	June, 1921	Small lump in upper outer quadrant of right breast	March, 1922	Tumor excised Dec., 1921. Radical mastectomy followed in two weeks	Diffuse induration around scar and drainage tract. Skin reddened
23	M. W. Dr. Lee No. 32400	36	M	3	No	May, 1922	Tumor upper outer quadrant of right breast	March, 1923	Excision of breast tumor and dissection of axilla	Right breast the seat of a firm carcinoma. Induration along scar. Œdema of skin red and indurated. Nodes on right supraclavicular fossa
24	C. I. Dr. Stone No. 32463	44	S	0	No	—1918	Lump size of an egg in left breast	Sept., 1922	Excision of tumor and axilla 1921. Recurrence treated by excision after 18 months. Another recurrence excised 1923. X-ray after last excision	Area of left breast patchy. Red with nodules. Deep subcutaneous nodules. Skin markedly involved in inflammatory process
25	B. W. Dr. Lee	42	M	3	No	April, 1923	Mass involving outer three-quarters of left breast	Oct., 1923	Radical amputation April, 1923. Postoperative X-ray cycle. Inflammatory recurrence 5 mo. after	Diffuse reddened, thickened, tender skin. Extends from midline anterior to anterior axillary line and 12 in. down from clavicle. Left supraclavicular nodes. Severe pain
26	R. F. Dr. Lee No. 27669	44	M	1	No	—1915	Small lump in right breast	May, 1920	Radical mastectomy. Recurrence 6 weeks afterwards inflammatory	Dull red patch about scar. Left breast now involved. Large node in left axilla. Cough
27	M. D. Dr. Lee	29	M	2	Yes	Feb., 1923	mall lump in left breast which had been struck causing pain and inflammation of the entire breast	Dec., 1923	Radical mastectomy right breast Sept., 1923. Redness of skin recurred 2 months after operation	Skin infiltration about scar with blush toward the neck. Large node in axilla. Small node behind left clavicle
28	O. B. Dr. Lee	48	S	0	Yes	Aug., 1923	Tumor in right breast following trauma the day previous. Skin became reddened two weeks later	Mar., 1924	Radical mastectomy Sept., 1923	

CARCINOMA OF THE BREAST

Chest plate	Path. type	Treatment	Result of treatment	Course	Duration		Total duration	Result
					before admission	after admission		
June, 1922, Metastasis in lungs		June, 1922, Sept., 1922, X-ray cycles. Sept., 1922, Radium pack. X-ray cycle	No relief from pain. Some diminution in redness of skin. Rapid recurrence after 8 weeks of improvement	Rapid extension of pulmonary metastases. Bone metastasis to acromion and pelvis	11 mo.	5 mo.	1 yr., 4 mo.	Died.
Sept., 1923 Lungs show probable carcinoma metastases		Mar., 1923, X-ray cycle. Aug., 1923, X-ray cycle (Failed to keep appointment)	Little palliation	Pain in scar, left supraclavicular fulness increased. Operative area shows increased redness with ulceration. Died Feb., 1924	1 yr.	1 yr., 4 mo.	2 yr., 4 mo.	Died.
Dec., 1923, Lung metastases present		Oct., 1923, X-ray cycle Dec., 1923, X-ray	Skin redness decreased	Pain in left arm. Metastasis to spine causing paralysis	1 yr., 8 mo.	1 mo.	1 yr., 9 mo.	Died.
April, 1922 Large nodes in right hilum		Mar., 1922, X-ray cycle. May, Dec., Jan., Feb., 1922, X-ray	March., 1922 No evidence of disease	Recurrence in right axillary nodes and supraclavicular fossa. Right neck is rapidly being involved	10 mo.	1 yr., 11 mo.	2 yr., 9 mo.	Doing poorly.
March, 1923, Chest plate neg. for metastases. June 1923 neg.		Mar., May, June, July, 1923, H. V.	No palliative result	Rapid progress of disease. Ulceration of scar and œdema	10 mo.	6 mo.	1 yr., 4 mo.	Died.
Sept., 1922, No evidence of lung metastasis		Sept., Nov., 1922; Mar., 1923; July, 1923; X-ray. Sept., 1923, X-ray cycle	Regression of nodules and clearing up of skin	Redness of skin recurred. Inflammatory process in right breast has begun and cannot be controlled	4 yr.	1 yr., 3 mo.	5 yr., 3 mo.	Original lesion is fairly well controlled.
Oct., 1923, Evidence of lung metastases	Scirrhous carcinoma	Oct., 1923, X-ray cycle	Little improvement	Rapid progress of symptoms, local and general	6 mo.	4 mo.	10 mo.	Doing badly.
May, 1920, Lung metastases present		May, 1920, X-ray cycle	No improvement	Rapid decline	5 yr.	1 mo.	5 yr., 1 mo.	Died.
Dec., 1923 Chest plate showed no metastasis		Dec., 1923, X-ray cycle begun	Insufficient treatment given	Died of scarlet fever Feb., 1924. Autopsy purulent pleurisy. Pericarditis sepsis. Report from another hospital	10 mo.	1 mo.	11 mo.	Died.
Mar., 1924, No evidence of pulmonary metastasis		X-ray elsewhere		Rib and pelvic metastasis. Hopeless case	6 mo.	1 mo.	7 mo.	Hopeless case.

The blood chemistry in Cases 4, 15, 16, and 17 was studied by R. C. Theis and the following results obtained:

Case	Non-Protein Nitrogen	Urea Nitrogen	Uric Acid	Sugar Mg. per cent
4	23.9	11.9	4.8	.145
15	26.6	14.	3.4	
16	28.1	9.1	3.4	.123
17	30.5	18.2	4.4	.144
Avg.	27.2	13.3	4.0	.137
Avg. 13 cases Thies and Stone	27.4	13.5	3.02	.127

The results in these 4 cases confirm the findings of the authors mentioned, concerning the blood chemistry of cancer patients in general and cancer of the breast in particular. Therefore, we believe that there is nothing peculiar in the chemistry of the blood in inflammatory carcinoma of the breast.

TREATMENT

Our attention was called to this phase of mammary disease when we encountered an early and almost immediate recurrence following a radical operation. Since that time frequent repetitions of this experience in cases operated elsewhere have made us more certain as to the inefficiency of surgery in the treatment of this disease. The explanation for surgery's failure probably lies in the diffuse invasion of the dermal lymphatics. Almost any line of incision passes directly through invaded lymphatic vessels and venules with no barrier to prevent immediate recurrence or wide dissemination through several lymphatics or blood vessels.

Here then, is a distinct clinical group in the field of mammary carcinoma in which all cases do badly if treated surgically, with an almost immediate and extensive recurrence and a rapidly fatal result. We believe that operation has been displaced for all time by radiation, unless some more efficient treatment than radiotherapy shall be discovered. This holds good even though the anatomical setting of the case is an operable one (i.e., a movable tumor in the breast, with a few nodes in the axilla).

In the majority of cases, external radiation by the low voltage machine has been employed under the direction of Dr. Herendeen, the roentgenologist of the Hospital. The low voltage treatment consists of five or more exposures over involved areas, using a peak voltage of 135,000 to 140,000 volts, with 4 or 5 milliamperes of current, a focal skin distance of 10 or 12 inches, and 4 millimeters of aluminum filtration. Over the breast and involved nodes a time of 15 minutes is employed. Over the outlying areas of cutaneous involvement, a more superficial type of radiation is used, with a time of 5 to 7 minutes. The dosage in each instance must be planned to meet the need of the individual patient. Time intervals between treatments are usually 2 to 4 days, depending upon the patient's general reaction to treatment.

The cycle of treatments is repeated in 6 to 8 weeks or longer, if regression has been insufficient or the disease has remained stationary. Treatments are not repeated simply because the condition of the skin will stand further radiation.

In those patients with large, bulky breasts, very satisfactory regression has been obtained by the use of higher voltages. Two hundred thousand peak volts are employed with 4 milliamperes of current, a focal skin distance of 20 inches, and a filtration of ½ millimeter of copper and 1 millimeter of aluminum. The time of exposure is usually 60 to 80 minutes with a time interval between treatments of several days. In such a case, lower voltage may also be used for the disease beyond the confines of the breast.

Radium as an external agent has seldom been tried, as the response to X-ray has been so uniformly satisfactory. Experience may ultimately show that external radiation over the breast proper may be still more efficient when radium is employed, because of the shorter wave length obtained. In one or two cases the introduction into the mass of radium needles, with a filtration of 0.4 millimeter of platinum, combined with X-radiation externally has given excellent primary regressions.

At present our main reliance in coping with the condition must rest upon well-planned X-ray treatment. The danger of over radiation must always be borne in mind, especially when higher voltages are employed.

RESULTS

Of the 28 cases under report, 14 are dead and 3 have been observed too recently to arrive at any conclusion as to the results of treatment. Of the remaining 11 patients, 4 are doing well, while 7 are succumbing to the disease. The average duration of disease after admission to the hospital is 8.3 months, while the average total duration of the disease in all 28 cases is two years.

Patients that do best by radiation are those who have had no previous surgical intervention; therefore, the primary cases have yielded the better results. Of the 18 primary cases followed, the average duration after admission to the hospital was 10.7 months, whereas, the 10 recurrent cases gave an average duration of but 7.3 months. Two of the primary cases, 6 and 10, presenting menacing symptoms at the time of admission, have done exceedingly well under radiation treatment. One of these is now in excellent health 14 months after admission, while the other is in good condition 1 year and 6 months since our first observation. In both instances there has been a decided gain in weight with no obvious extension of the disease. The most striking improvement is exhibited by regression in the tumor itself as well as in the inflammatory phenomena.

Treated by well planned radiation, these cases live for 1 or 2 years, which is certainly more than any surgical treatment alone or combined with radiation can offer. Moreover, the patients are much more comfortable under the conservative plan of treatment.

CONCLUSIONS

1. Inflammatory carcinoma appears to be a distinct clinical phase of carcinoma of the breast.

2. Generally, this type has been unrecognized, being frequently mistaken for other diseases of the breast.

3. The inflammatory appearances are characteristic.

4. This variety of mammary cancer shows no constant pathological type.

5. The most striking pathological change is a wide invasion of dermal lymphatics by carcinoma.

6. Bacteriological and biochemical studies have failed to explain the inflammatory manifestations.

7. The cases do badly if treated surgically.

8. At present radiation offers the only hope of palliation, diminishing the patient's suffering, and giving a definite prolongation of life.

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A NEW METHOD OF RESTORING THE LUMEN IN A CASE OF IMPERMEABLE STRICTURE OF THE ŒSOPHAGUS

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TO the general dissemination of the knowledge and the technique of examining the œsophagus must be attributed the large number of case reports of stricture of the œsophagus and the early attempts at alleviating a very distressing condition. The large majority of cicatricial strictures of the œsophagus are the result of the accidental swallowing of some corrosive acid or alkali, and it is probably the general popularity of the various cleaning mixtures containing these corrosive substances that accounts for the large number of cases of stricture. In a report issued this year from the Bronchoscopic Clinic at Jefferson Hospital, Philadelphia, Dr. Louis Clerf records 20 cases which have been entered and treated during the past 2 years. In each case the stricture was the result of accidental ingestion of some cleaning mixture.

The site of a stricture of the œsophagus varies and the method of treatment depends at times on whether the stricture is located at the upper or lower end of the œsophagus or in the middle œsophagus. In some cases more than one stricture is present, situated at different sites. If ordinary œsophagoscopy with bouginage is indicated and the stricture is amenable to this treatment, the site of the obstruction is not so important, but a stricture which completely occludes the lumen of the œsophagus and resists all efforts at bouginage, is best and most safely treated if the stricture is located at the upper or the lower end. For in a true case of complete occlusion of the œsophagus at the lower end it is possible to do a gastrostomy and get an exposure of the œsophagus for a direct view of the stricture. In a complete stricture located at the upper end an exposure of the œsophagus to external surgery entails no great danger to the patient. The external surgical treatment of strictures of the middle œsophagus, however, is fraught with great danger. The technique is very difficult, and up to the present time the mortality has been exceedingly high. Probably the further development of external surgery of the œsophagus will solve the problem of treatment of impermeable strictures of this area, but until this evolution occurs we can only continue our efforts to make the treatment through the œsophagoscope more painstaking and more free from danger.

With the hope of adding something to the technique, the following is offered in illustration of a method of restoring the lumen of a completely occluded œsophagus in the thoracic portion with less danger to the patient.

A review of the literature dealing with strictures of the œsophagus reveals comparatively few cases which are truly impermeable. Very many cases are referred to as impermeable which fail to respond to ordinary bouginage but which later are passed by the string swallowing method or retrograde bouginage or some other method which discloses the fact that the strictures are not really impassable. It was a surprise to learn that complete occlusion is so rare. Hence a brief résumé of the cases recorded will probably be of value at this time.

Chevalier Jackson in *Peroral Endoscopy* states: "Strictures of the middle third of the œsophagus are not amenable to treatment by any means at present known, and the patient will have to be satisfied with gastrostomy until transthoracic œsophagotomy has been fully developed." The same author in *Bronchoscopy and Œsophagoscopy*, 1922, states: "Impermeable strictures of the middle third of the œsophagus have not been successfully treated by surgical methods."

A few months ago a case of stricture of the œsophagus in the middle third was reported from the Bronchoscopic Clinic at Jefferson Hospital in which a perforation was made in the stricture by means of manipulation during combined peroral and retrograde œsophagoscopy. Unfortunately, the child developed measles and bronchopneumonia and died.

Dr. J. Murphy and Dr. Samuel Iglauer in *Transactions of the American Laryngological, Rhi-*

nological and Otological Society reported a case of complete occlusion of the lumen in the middle œsophagus in which they attempted to restore the lumen by means of the electric cautery. The peroral endoscopist used the cautery while observing the light of the retrograde œsophagoscope as a guide. Following the operation the patient was able to swallow, but 14 days later he succumbed. The cause is not known.

Gussenbauer in *Zeitschrift fuer Heilkunde*, 1883, iv, 33, described a method of curing impermeable stricture of the œsophagus in the thoracic region, and Carl Bayer in *Prager medizinische Wochenschrift*, 1894, xix, 39, reported a case treated by this method. The technique consisted of exposing the œsophagus down to the thoracic aperture and pulling it up as far as possible. After making an incision into the lumen, a small knife was inserted and pushed blindly down into the stricture, and gradually, by the use of the knife and a small metal bougie, the lumen was restored. The patient recovered and was under observation for 4 years.

In the *New York Medical Journal*, 1890, li, Dr. F. Lange reported a case of stricture 5 centimeters above the diaphragm. He stated that by constant manipulation from above and below a small whalebone bougie passed through the stricture from above down.

H. M. Taylor in the *Charlotte (N. C.) Medical Journal*, 1901, described a case of impassable stricture of the lower end of the œsophagus in which he restored the lumen by forcing a small whalebone bougie through the stricture and by afterward cutting the stricture by the Abbe string-saw method.

Honigman in *Jahresberichte der schlesischen Gesellschaft fuer vaterlaendische Kulture*, 1900, lxxvii, 41, presented a patient who had been operated upon. In this case a stricture was found just above the cardia which resisted all attempts to pass a bougie. By passing, what he terms, a hollow bougie down to the stricture he was able to push small celluloid probes through the stricture. After this was done the patient gained 10 pounds in weight in a very short time.

In the *Revue de chirurgie*, 1912, xlvi, H. Alamartine and L. Sargnon report a case in which the œsophagotome was used successfully. The patient lived 4 years. A second case in which the œsophagotome was used is reported as resulting fatally for the patient, a child of 4 years.

Herman Fischer in SURGERY, GYNECOLOGY AND OBSTETRICS, 1911, xii, reported a case in which he performed a transthoracic cardiotomy in a boy of 6 years, in whom every attempt at restoring the œsophageal lumen had failed. The result of this piece of work was not determined because the child died after the completion of the operation through some unfortunate accident to the anæsthesia apparatus.

Dr. Willy Meyer presented a patient with a complete stricture of the œsophagus at the New York Surgical Society, about the year 1903. In this case he made an osteoplastic flap of the ribs for gastrostomy, pulled the œsophagus upward along with part of the stomach, and through this excellent exposure of the œsophagus and stomach attempted to perforate the stricture which was located just above the cardia. In spite of all efforts, the manipulation failed.

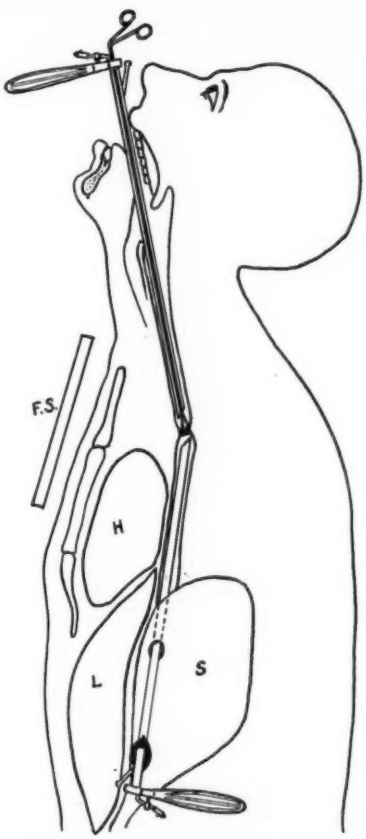

Fig. 1. Diagram representing roughly the relative positions of the œsophagoscope and forceps as well as the fluoroscopic screen above the patient. f. s., Fluoroscopic screen; h, heart; l, liver; s, stomach.

The literature concerning stricture of the œsophagus is voluminous and it is possible that the aforementioned cases do not represent the entire number reported. However, I have searched carefully for all reports of impassable stricture, and I am inclined to believe that they are rare and that probably they will become more rare as our knowledge of the subject increases. At least these cases

serve to establish the point that adequate means of handling strictures of the middle third of the œsophagus are wanting.

The case which I wish to present had a complete stricture of the thoracic portion of the œsophagus, and I was able to restore the lumen by the method herein described:—

G. T., age 24, entered the Cincinnati General Hospital by way of ambulance from Dayton, Ohio, on August 11, 1922. Her condition was grave; temperature, 97 degrees; pulse, 60; respiration, 24. She was greatly emaciated and in dire need of fluids. Water and food were adminstered by rectum immediately. The history of the case revealed the fact that on January 17, 1922, in a fit of anger, following a quarrel with her fiance, the patient swallowed a mixture containing two tablets of bichloride dissolved in a small quantity (2 ounces) of lysol. She was given milk to drink a short time afterward and vomited. She was rushed to the hospital in an ambulance at Rockford, Illinois, where she was living, and on arrival there the stomach pump was used. During a sojourn of 11 days in the hospital she was able to swallow only a small amount of liquids but refused further treatment and went to her home at Dayton, Ohio. Here she was under the care of her family physician, who tried to dilate the œsophagus with a bougie and a rubber tube but was unsuccessful. She grew worse and was removed to the hospital at Dayton on April 15. At this time she had lost much weight and was unable to swallow anything except small quantities of water. At the hospital a surgeon made various attempts to dilate the stricture but was unsuccessful, and on May 2 a gastrostomy was performed. On July 1 she was dismissed from the hospital with the gastrostomy wound open and informed that the restoration of her œsophageal lumen was impossible. Shortly afterward the tube was removed and the gastrostomy wound allowed to close, after which she found she could not swallow anything. She remained at home without fluids of any kind for 3 or 4 days before she came to the Cincinnati General Hospital. On the day following her arrival here the gastrostomy wound was reopened and a tube was inserted by Dr. Carter. A few days later an X-ray and fluroscopic examination by Dr. Carl F. Little revealed the following: "Fluroscopic examination of the œsophagus of G. T. shows a complete stricture at about the third interspace. No barium passed this point in spite of repeated efforts at swallowing. . . . X-ray plate of G. T. reveals a complete stricture of the œsophagus at about the third interspace. There is considerable pouching above this point." A few days later the patient was placed on the table and an œsophagoscope was passed revealing a stricture about 8½ inches from the incisor teeth. All attempts at bouginage were firmly resisted. A small Mosher œsophagoscope was then inserted into the œsophagus from below but to no avail as the smallest bougie found firm resistance.

The patient's general condition improved very much with the gastrostomy feeding and about 10 days following her admission to the hospital an attempt to restore the lumen was decided upon. The patient received a hypodermatic injection of morphine sulphate gr. ⅜ with atropine sulphate gr. 1/150. The stomach was washed thoroughly and emptied by means of suction until all fluids returned clear. A Jackson medium œsophagoscope was passed from above and a small Mosher œsophagoscope passed from below. With these two instruments in position the patient was removed to the fluroscopic room, where, under the guidance of Dr. Carl F. Little, roentgenologist in charge, the two œsophagoscopes were brought into alignment under the fluorscope. Long biting forceps were then pushed downward through the upper endoscope on to the stricture which appeared to be one-half to three-quarters of an inch in thickness. By means of biting and pushing, under close observation through the fluoroscope, the forceps passed through the stricture into the mouth of the retrograde œsophagoscope. Dr. Kuhn, who maintained the lower instrument in position, saw the forceps enter. The instruments were removed immediately and the patient was put to bed under close observation. No untoward symptoms having developed, an upper œsophagoscopy was done the next day and a small filiform bougie, on which a string had been securely fastened, was passed into the stomach. The string was recovered from the stomach immediately and the bougie removed. Further dilatation was accomplished by means of small metal bougies run in series on the string from below. By the end of November it was possible to pass a No. 40 French bougie from above downward. The gastrostomy wound was allowed to close at this time as the patient was taking all her food by mouth. Around the middle of November she was instructed in passing the bougie on herself, and when she had accomplished this to our satisfaction she was discharged from the hospital. She had gained about 100 pounds in weight and has had no difficulty in swallowing any food. She continued to pass the bougie twice a week.

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A BRIEF REVIEW OF THE LITERATURE OF OSTEOMALACIA WITH THE REPORT OF A CASE NECESSITATING DELIVERY BY CÆSAREAN SECTION

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OSTEOMALACIA, representing in the minds of some observers a small but distinct chapter in osteopathology, is generally said to be extremely rare in English speaking countries. Whether or not this is strictly true is an open question, but the fact that it rarely engages the attention of the obstetrician is reflected in Williams' series of only three cases, and his quotation of an equivalent number in the clinic of Tarnier in Paris and in that of Hirst in Philadelphia.

Recently I have studied a patient in whom delivery by cæsarean section was necessary because of the deformity of the pelvic bones resulting from osteomalacia. My interest has stimulated me to review the literature upon the subject and to present the information which I have gathered in the hope that it will prove of value to surgeons whose field of study falls in the domain of obstetrics and gynecology. Excellent case reports have been published by Edelmann, Porges, Zak, Mangum, and other observers, but because of the apparent rarity of osteomalacia in this country, I have described my case in detail, and have included several X-ray studies which show the bony changes peculiar to this disease.

The whole subject of bone diseases has been admirably treated and brought up to date by Locke, whose article may well serve as a basis for a study of the known facts regarding osteomalacia.

The disease in question is generally considered to be acquired; runs a chronic progressive course with remissions and exacerbations; is most commonly seen in female adults, particularly as a complication of pregnancy and the puerperium; is clinically characterized by muscular weakness, pain, and deformity; and pathologically, by softening, bending, and fracture of the bones.

In contrast to such a specific conception, Bernard regards it only as a symptom-complex, and says: "One cannot consider osteomalacia a morbid entity due to a sole and constant cause; it is rather an anatomical-clinical syndrome, corresponding to the osseous decalcification." He adds: "Osteomalacia and rickets may be the same syndrome in varying degrees of intensity and in different localizations, but having the same anatomic substratum—decalcification combined with reaction on the part of the osteogenetic elements of the bone marrow." Jones and Lovett define osteomalacia as a symptom common to most diseases of deformed bone. The many points of resemblance between this syndrome and other similar disease-complexes involving the osseous system, render this viewpoint worthy of more than passing consideration. Von Recklinghausen after many years' study of osteopathology announced in 1910 his failure to draw a complete distinction between osteomalacia and rickets. De Biehler's report of a severe case of rickets, followed by progressive softening with fractures, and death at fourteen months—serves to illustrate the border-line status of this phase of the problem; and the presence of many outspoken cases of early and late rickets during the recent epidemics of "hunger osteomalacia," is similarly important.

Dieffenbach in X-ray studies has frequently found the lesion in cases of so-called chronic rheumatism and arthritis, and Koch describes abortive forms in localized areas.

The geographical distribution of the disease is fairly definite. It is most commonly seen in Italy, Germany, Switzerland, and India, particularly in certain valleys and specified locations. Because of the frequent coincidence of goiter in these sections, some observers, notably Hoennicke, attempted to correlate the bony lesions with an endocrinopathy of thyroid and ovarian origin, but,

from an experimental and clinical viewpoint, ineffectually. Few outspoken cases have been reported from the United States, and it is even more rarely seen in England, Japan, and Finland (Saltzman).

Because of the striking association between osteomalacia and pregnancy, a puerperal form is described. Since this type includes the great majority of all cases, it follows that males are relatively rarely afflicted, the number of the latter being variously estimated from 2 to 10 per cent. The non-puerperal form affects the sexes about equally, and the process is usually less severe, more generalized, and runs a slowly progressive course. The pelvis ordinarily suffers to a lesser extent.

Juvenile forms have been described by Avezzei and Molcho, but Zezas and others present evidence for a possible confusion with rachitic changes; while the so-called senile osteomalacia described by Weis, Looser, and Duschak, has been questioned by Drasche, and compared by Schiffmacher to a less complex osteoporotic process.

Heredity is generally thought to be a negligible factor in this disease. The average age incidence is placed by Scott at about 30 years, while Baetjer and Waters place it at a later period. It is apparent that the age limit must be somewhat restricted because of the frequent association with the childbearing function. Multiparæ are much more often afflicted than primiparæ, and Guthrie's figures place the average incidence between the third and fifth pregnancy. The fact that the occasional case under 20 years is apt to occur at puberty, again calls to mind the probable relation of ovarian function to the underlying disease process, but on the other hand, Molcho points out that in childhood the sex incidence is about equally divided.

Diet is undoubtedly a factor in the production of the disease, but experimental production of the lesions by dietary regulation alone has not been uniformly successful. In the more recent foreign literature, however, considerable study has been given to a syndrome characterized as "hunger osteo-malacia," differing little, if at all, from the classical forms of the disease (Hirsch), except in the more frequent affliction of males and elderly people and, as pointed out by Edelmann, in the variable response to oöphorectomy. Dalyell and Chick, and Hume and Nirenstein, in a series of cases from Vienna, report cures on a basis of dietary regulation alone, wherein such supplementary foods as cereals, animal fats, cod-liver oil, butter, and green vegetables furnished the essential factors. Clinically, the cod-liver oil acted with greatest specificity, and the vitamine "A" constituent of the diet was regarded as most significant. Szennes of Vienna, in 1921, likewise reports cases of osteoporosis with spontaneous fractures, which he attributes solely to dietary deficiency. Hoffman, by dietary regulation and the ingestion of cod-liver oil, plus an adequate phosphorus and calcium intake, obtained successful results in 23 cases of osteomalacia associated with painful and deforming spondylarthritis. Hahn considers the phosphorus to be most essential, and Latzko gives it in doses approaching the toxic figure. In Warsaw, Higier obtained satisfactory results in 70 cases through the systematic administration of vitamine "A." Cramer and Schiff arrived at similar conclusions in reports from Russia, while Heyer noted favorable results in Munich. Reichel and Von Struempell made thorough descriptions of the lesions, and Alwens has discussed the therapy, reaching conclusions similar to those of former observers. Brenner by the administration of cod-liver oil, fortified by a high calcium and phosphorus intake obtained a favorable result in a puerperal case after 6 months of total invalidism. The recently discovered dietary factors in other osseous diseases, notably in rickets, make it quite probable that the perverted calcium metabolism or vitamine imbalance in osteomalacia will soon be better understood.

The old theory of circulating organic acids resulting in a solution of the mineral constituents of bone, has been abandoned. The possibility of a specific organism being at fault (Petrone, Arcangeli) has been universally denied, although modern radiologists see evidences of an inflammatory change in the bony tissues. Marpurgo attempted to reproduce the disease by re-injection of a

supposedly specific organism, but with disappointing results. Hutchinson and Patel, however, quote the interesting fact that in India, certain patients suffer from "bone fever" following pregnancy, the lesion affecting chiefly the pelvis and thighs. These patients frequently seek the hospitals asking for cod-liver oil. The para-infectious theory, defended by some authorities assume a distant focus as the underlying cause of the complex, but this remains a theory.

An endocrinous etiology has been favored by many. Bossi gave adrenalin in large doses, on the basis of a supposed adrenal insufficiency; while Hoffman has followed with reports of a good response to frequently repeated injections. Both this series and that of Koltonski, however, who has claimed cures with adrenalin when castration has failed—were supplied with diets adequate in vitamine and inorganic salt content, so that it is difficult to give entire credit to any one therapeutic measure. Molcho believes in the adrenal complex as a factor in the production of osteomalacia, but makes the significant observation that the classic signs of defective function in these glands are usually absent. Edelmann favors the symptomatic use of adrenalin in small doses for the relief of pain.

Curschmann, in an extensive treatise upon pluri-glandular syndromes in osteomalacia, associates a hyperfunction of the thyroid with the non-puerperal form of the disease. The parathyroids, however, with their supposedly specific relation to calcium metabolism, have received amazingly little attention from the experimenters in this field.

Sellheim claims a specific inhibitory influence of the gonads upon bone growth; while Hanau favors a theory based on ovarian hyperfunction, and therefore has held out hopes of cure by oöphorectomy. Fochier, Fehling, Hellier, and others report favorable results from this method of treatment, the last observer having followed the cases by repeated X-ray examinations. However, McCrudden's later observations, to the effect that experimental osteomalacia is not cured by oöphorectomy, and that cases without ovaries may develop the disease, induce him to formulate another etiological conception, wherein the ovaries are not held so strictly and solely responsible. He interprets the apparent specificity of oöphorectomy as due more to its preventive effect upon further pregnancy, than to a definite metabolic change so inaugurated. He asserts that the increased calcium demands of pregnancy cause a relative depletion which cannot be compensated, remissions and exacerbations with repeated pregnancies probably representing a physiological reparative effort to keep pace with the destructive process.

Experimental metabolic studies warrant the conclusion that this process is not a simple passive halisteresis, but an actively accelerated bone metabolism associated with a loss of calcium and a retention of sulphur and magnesium. The old bone is destroyed and new is formed, the latter being similar to the organic-matrix of the normal; and the deficiency in calcium-phosphate is replaced by magnesium phosphate. The decrease of inorganic, and the increase of organic constituents cannot be accounted for by decalcification alone, but by the production of an osteoid tissue as well—a view in accordance with previously established conclusions. Since the calcium loss exceeds the phosphate reduction, the anhydrous phosphoric acid—calcium oxide ratio is somewhat high. The magnesium and sulphur are increased to about four times the normal amount, the former replacing the calcium, and the latter being a normal constituent of the matrix.

White states that although in certain puerperal forms the skeletal changes become worse with each succeeding pregnancy, there is a tendency to spontaneous recovery when the drain of pregnancy and lactation is removed, especially when calcium and phosphorus are added to the diet in usable form; and that the ability to assimilate these salts determines whether the lesion is transient or permanent. In the latter case, an endocrine imbalance is considered causative. Steenbock and Hart demonstrated experimentally that the production of milk made heavy drains upon the skeleton unless the calcium and phosphorus intake was abundant, but

that an imbalance of mineral metabolism whereby lime salts are excreted in excess, depends in part upon factors independent of the intake. The nature of these factors is as yet undetermined.

White reproduced the disease in rats by feeding them the normal diet of a species of monkey susceptible to the disease. His analyses seemed to justify the following conclusions:

The perverted metabolism of calcium and phosphorus may be due:

1. To essential deprivation of alkaline salts from the diet (famine type);
2. To a drain of alkali from the normal storage foci;
3. To a combined action of a diet, faulty in more than its salt content, which by the production of acid in its oxidation, and by favoring the development of acid-forming bacteria, causes a drain of body alkali for the neutralization of this acid; or,
4. To a combination of all these factors, acting on the endocrine system, and through it, altering the inorganic metabolism.

The non-puerperal forms frequently show evidences of tissue calcification, suggesting a similar drain upon the skeletal "storehouse of lime," wherein the lime salts go into solution, followed subsequently by deposition in foci of relatively high acid reaction (stomach, lungs, kidneys).

The etiology, therefore, is unknown, and it rests in the underlying cause of the metabolic perversion, which results in the outstanding symptom—osteomalacia. The inadequacy of current theories of etiology is emphasized in the observations of Hutchinson and Patel. They point out that in India many individuals and classes, subjected to the same environmental conditions, climate, water supply, housing, diet, etc., suffer in no logical or orderly sequence; that child marriage and prolonged lactation cannot be alone indicted, because these practices elsewhere are entirely unassociated with the disease; that practically all cases are found in females whose diet is identical with that of the males; and that the disease is common in the upper-classes where the dietary is over-abundant. The Mohammedans are much more commonly afflicted than the Hindus, while the diet of the two castes is identical. The striking point of difference in the rituals of these two classes lies in the purdah system of the former according to which the women are never unveiled in public, rarely leave their houses during the day, and always cover themselves entirely with black garments.

The pathology of this syndrome termed osteomalacia consists largely in a description of the end-results as seen clinically, radiographically, and at autopsy. The soft and friable bones bend and fracture easily, the deformities occurring in consequence of natural mechanical forces, rather than from any intrinsic tendency. The non-puerperal type may affect any part, but the puerperal modification selects the pelvis primarily. The normal pressure relations cause the sacral promontory to fall downward and inward, while the ilia are compressed laterally by the inward force of the femora. This creates the "trefoil," or "clover-leaf" shape of the pelvic inlet, while the forward extension of the superior pubic rami forms the characteristic "beaked" symphysis. Outlet changes are equally constant and result in a close approximation of the inferior pubic rami and ischial tuberosities, in contradistinction to the flaring arch of advanced rickets. The actual amount of distortion varies with the age, the extent of the decalcification and the forces in action over prolonged periods. That the pelvis is involved constantly and early is the observation of Hanau who recognizes a "physiological osteomalacia" of pregnancy from postmortem studies upon early bone changes. This fact lends support to the statement that the disease is doubtless more common than has been heretofore assumed.

The vertebræ are ordinarily next affected in order of frequency, the individual involvement resulting in a total shortening, which causes an apparent elongation of the arms and an actual approximation of the ribs and iliac crests. Scoliosis with exag-

geration of the normal curvatures is the rule. Thoracic deformities do not conform to any type, but a decrease in the antero-posterior diameter due to a depression of the sternum is common. Finally, the femora and tibiæ are involved, showing irregular and bizarre bending at times, with or without fractures. The epiphyses are not affected. The skull is rarely involved unless by a diffuse thinning, while flattening of the fingers may or may not be present, as a result of efforts at rising. The joints and muscles may show atrophy, with or without ankylosis in the former and fatty degeneration in the latter. There is no constant alteration in the endocrine glands or viscera.

The actual osseous changes affect both cortex and medulla. Decalcification causes a reduction of 50 per cent or more in specific gravity, and the consistency is such that the bone can be easily cut with a knife, leaving a yellowish or hyperæmic surface. The periosteum is thickened, adherent, and hyperæmic, resembling the changes seen in Paget's disease, but in contrast to the unchanged periosteum of ostitis fibrosa. The subperiosteal tissue is characterized as pulpy, and the cortex is narrowed, with thinning or absence of the trabeculæ. Decalcification is prominent. The marrow spaces are enlarged, and sometimes cystic. If the essence of the gross pathological alterations were to be summarized in a phrase—it could best be characterized as "softening without hypertrophy"; and since fragility usually precedes the softening, spontaneous fractures are early, and very suggestive of the diagnosis.

Von Recklinghausen, von Ribbert, Tashiro, and Schmidt have contributed fundamentally to the histological study, and the accepted picture represents a primary decalcification of the lamellæ, where they are crossed by the perforating canals, leaving a zone of osteoid tissue rich in osteoclasts, and formed of proliferating medullary membrane as well as periosteum. Secondly, this osteoid tissue is, in part, a formative reaction, resulting from the laying down of uncalcified new bone.

The symptomatology of osteomalacia is only definite in the late stages; and consequently it is rarely recognized in the beginning. The onset is gradual and irregular, but most authors place emphasis on the rheumatoid pains, tendency to fatigue, and difficulty of locomotion prior to the appearance of deformities, this syndrome being frequently confused with rheumatism or sciatica. The pains are of variable intensity, and are aggravated by movement or pressure. In the case of women, pelvic pain is ordinarily first noted, while male patients show vertebral involvement early, and in childhood the extremities are predisposed. Hahn asserts that pain upon lateral compression of the thorax, with exaggerated pain upon release of pressure, is a constant early symptom. In vertebral involvement girdle pains may be present, or even symptoms from compression of the cord, with disturbed reflexes, altered sensation, tremors, and occasionally paralysis. Muscle spasm is the rule, and mobility is voluntarily restricted. The gait is shuffling, and the patient is disinclined to lift the feet. In early life, there may be some confusion with rickets, but the epiphyses are uninvolved. Deformity may be early, and manifests itself in diminished height, thoracic alterations, arched clavicles, pelvic compression, or anterior bowing of the legs. Fractures, contractures, ankylosis, distortion, atrophy, and cachexia are late symptoms, and are usually associated with secondary functional or constitutional disorders.

Blood changes are inconstant and not characteristic. Mild leucocytosis and secondary anæmia are seen; while an occasional relative increase of myelocytes and eosinophiles is reported by Eichhorst. Blood calcium is likely to be increased, and Scott has reported a slight increase in urinary calcium, with a relative deficit in pregnancy and lactation.

The diagnosis rests largely, therefore, upon the symptomatology as described, with due consideration of the age, sex, relation to pregnancy, and the nature of the deformities. The one outstanding aid in a correct interpretation lies in the X-ray findings. The bones are abnormally indistinct and poorly differentiated from the surrounding

soft parts. Their contour is irregular, with variable curvatures due to an irregularly thickened periosteum. The rarefied cortex is smooth, but thin, with destruction of the trabeculæ. Long striated areas parallel to the shaft are due to absorption. Reparative processes are practically never seen. Small benign cysts may occur in the pelvis, long bone, metacarpals, and phalanges. Fractures, especially of the ribs are common, with notable absence of callus formation. The marrow cavity is expanded. The vertebræ show decreased density, with diminution of the vertical height, and with or without cupping. The epiphyses may share in the generalized rarefaction, but the joints are altered only by secondary changes in the weight-bearing surfaces.

CASE REPORT

A twenty year old American negress who had been married 2 years, was first seen in the tenth month of her first pregnancy. Menstruation began at 15 years, maintained a 28-day cycle, and lasted about 6 days, usually with an associated dysmenorrhœa. The last menstrual period was June 6, 1922, and the expected date of confinement, March 13, 1923. Throughout the pregnancy, the patient's general health was good, occasional vomiting in the early months, slight headache, and chronic constipation being the only subjective abnormalities elicited.

The patient's mother died of cardiac disease of an unknown type, otherwise the family history was irrelevant.

The past history is of particular interest because of the time relation between previous infectious diseases and the development of the bone changes. Mumps, whooping-cough, and chicken-pox in early childhood are recorded. However, the general development was normal, and there was no clear history of early rachitic changes. There were frequent attacks of sore throat and tonsillitis, but no history of acute rheumatic fever.

In October, 1918, at 15 years of age, the patient was admitted to this hospital with influenza and bronchopneumonia. These diseases ran a typical course, ending in an apparent cure, but the general physical examination brought out two points of interest: (1) the heart showed a short, low-pitched systolic murmur, followed by a faint diastolic murmur in the pulmonic area, and accompanied by a marked accentuation of the second pulmonic sound; while (2) no mention is made of any demonstrable skeletal alterations. X-ray observations were not made. The physical examination was necessarily superficial, and special studies were of minimal number and character because the patient was seen during the influenza epidemic; but it is safe to assume that the bone disease was not far developed, if at all, for the patient had been regularly employed as a waitress previous to the attack of influenza.

Although afebrile when discharged in 1918, the patient had not been out of bed. She could sit up, but the legs were incapable of maintaining her in the upright position; and after a month at home, crutches were employed. Later, locomotion was aided by grasping solid objects. Pain in the lower limbs, associated with frequent headaches, were the only subjective features, but the legs became markedly bowed within the first 2 or 3 months at home.

On the present admission, March 11, 1923, her temperature was 98.2 degrees, pulse 100, respiration 22, blood pressure 108-50. Physical examination at this time showed a rather short, small-framed, poorly nourished negress (Fig. 1) without signs of discomfort while recumbent. However, because of pain upon standing, the patient helped herself to maintain the upright position by grasping solid objects, and walked with a wide swinging gait, hardly lifting the feet from the floor. Lateral compression of the thoracic wall, in the act of assisting her to remain upright, caused local pain of marked degree. The head was roughly triangular in outline, due to a slight increase in the biparietal diameter. The chest was symmetrical, but showed a sharp anterior angulation at the junction of the manubrium with the body of the sternum. The transverse diameter was narrow, producing the typical pigeon-breast, but no groove of Harrison was demonstrable. The costochondral junctions showed symmetrical nodular enlargements The upper extremities were relatively elongated because of the shortening of the trunk; and there was a definite enlargement of the hands, with clubbing of the fingers. The spine showed a left dorsal scoliosis of mild degree and a slight lumbar kyphosis. There was an anterior bowing of the tibiæ, and a less marked lateral curvature, with sabre shins. However, the lower extremities did not appear distinctly shortened. The distal ends of the femora and the proximal extremities of the tibiæ were enlarged and flattened; and, while the knee and ankle joints functioned poorly, no essential arthritic disorder was demonstrated. Œdema was absent.

In the lungs a slight relative dullness was elicited below the right scapula associated with decreased breath sounds at both bases, but there were no râles. The apices and infra-clavicular fossæ were shrunken, and there was a marked episternal pulsation and thrill.

The heart presented classical signs of mitral stenosis and insufficiency, probably of rheumatic origin—and of aortic insufficiency, with well marked peripheral vascular signs. There were neither history nor present signs of cardiac decompensation. The other positive physical findings consisted in (a)

Fig. 1. The tendency to minimize weight-bearing upon the lower extremities is shown. The triangular head and the sharply angulated sternum are seen, as well as the relative elongation of the arms and hands with clubbing of the fingers. The bowed and sharp tibiæ, with flattened ends are noticeable. The spine showed a left dorsal scoliosis of mild degree and a slight lumbar kyphosis. The scoliosis is suggested in the photograph.

Fig. 2. The trefoil outline of the superior strait is clearly shown with the transverse contraction from inward trochanteric pressure. The beaked symphysis is demonstrated while the narrowing of the pubic arch is less evident upon the plate. The bone substance is characterized chiefly by generalized halisteresis best seen in the vertebral bodies and the upper extremities of the femora. A medium size cyst is present near the posterior spine of the left ilium

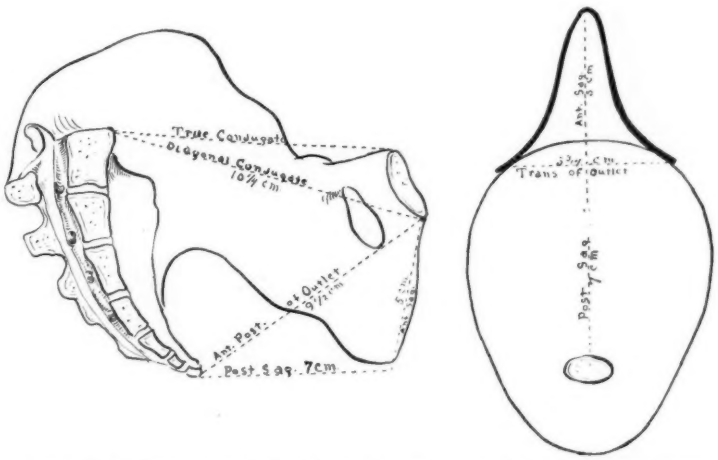

Fig. 3. The diagram upon the left shows the significance of the anterior and posterior sagittal diameters; that upon the right shows the character of the pelvic outlet necessitating delivery by cæsarean section.

Fig. 4. Note the marked rarefaction characteristic of all the bones, as well as a definite cyst in the third metacarpal, a finding said to be constant in advanced lesions.

a slight exophthalmos, with positive von Graefe and Joffroy signs, impaired convergence, one pupil slightly irregular, but intra-ocular reflexes normal; (b) enlarged and cryptic tonsils, with purulent foci on the right side; (c) slight pharyngeal injection; (d) small, firm, discrete glands in both anterior and posterior cervical triangles; (e) pyorrhœa, and (f) a papular eruption over the anterior thoracic wall.

The abdomen was of moderate size, the 9 to 10 months' fetus lying in the left occipito-anterior position. The heart sounds were audible in the left lower quadrant, and the head was floating, definitely disproportionate to the pelvic inlet.

Pelvic examination revealed no abnormalities of the soft tissues, but allowed accurate palpation of the bony inlet. The superior strait proved to be of typical trefoil shape (Fig. 2), with marked bilateral encroachment of the iliac bones upon the superior pubic rami, resulting in the "beaked" symphysis said to be typical of osteomalacic changes. The pubic arch was short and narrow, the inferior pubic rami running practically parallel throughout their length. The sacrum showed little change in the vertical concavity, but definite decrease in the lateral concavity. There was no palpable false promontory. The pelvic measurements were: interspinous, 24 centimeters; intercristal, 25 centimeters; intertrochanteric, 26.25 centimeters; Baudeloque, 20 centimeters; diagonal conjugate, 10.25 centimeters; bituberal, 5.75 centimeters; anterior sagittal, 5 centimeters; posterior sagittal, 7 centimeters; antero-posterior, 9.50 centimeters.

The Wassermann reaction was on repeated test, 4+. The urine contained a faint trace of albumin without casts. Electrocardiograms demonstrated, (a) left ventricular preponderance, and (b) sino-auricular tachycardia. Complete blood counts fell within normal limits—and a stained smear showed no abnormal forms. The white cell count of 6,240

Fig. 5. Bowing of the femora is demonstrable, as well as an advanced osteoporotic change.

(76 per cent polymorphonuclears) at the time of labor might be considered a relative leucopænia.

Consideration of the mode of delivery quickly resolved itself into an elective cæsarean section, chiefly on an absolute pelvic indication. This was furnished, first, by the pelvic inlet. Although a diagonal conjugate of 10.25 centimeters in itself would not render spontaneous delivery impossible, especially in a negress with a small fetus, yet the available diameters of the superior strait were so diminished by the coincident transverse shortening that pelvic dystocia would have been complete. Secondly, the outlet contraction clearly indicated the procedure, because the noteworthy shortening of the transverse diameter was not compensated by a corresponding lengthening of the posterior sagittal diameter (Fig. 3). In addition to the indication based on actual figures, it was grossly apparent that even should the vertex enter the superior strait, the pubic arch was so contracted as to prohibit the engagement of the head to any appreciable degree in the anterior segment of the inferior strait.

The contraction was tentatively attributed to an extreme grade of rickets—and the pelvis classified as "generally contracted rachitic—of pseudo-osteomalacic type."

Consultation upon the question of cardiac reserve for general anæsthesia resulted in a favorable prognosis.

The patient went into labor the night preceding the appointed date of delivery, and cæsarean section was executed prior to the rupture of the membranes, and within 3 hours of the time of initial contractions. The operation was uncomplicated, except for the difficulties attending an anterior placental attachment, and the child was delivered in good condition. It was thought best not to effect sterilization because of the fact that the patient was a young primipara; that the child might be lost subsequently from extra-obstetrical causes, and because close observation of the patient in the future was anticipated. Gas-oxygen anæsthesia was well tolerated, and the patient was left in good condition.

The second day following operation, the temperature rose to 101.5 degrees, but soon fell to normal. The associated pulse of 130 gradually returned to normal on the sixth day, where it remained except for occasional transient periods of asymptomatic tachycardia. Wound healing was excellent, and only when the patient was allowed out of bed did the generalized pain and tenderness recur. Excruciating pain was experienced in the lower extremities upon any attempt at locomotion, and the distress was largely localized to the "knees"—although the skeletal elements were probably at fault, rather than the joints themselves. The pelvis, back, and thorax showed similar tenderness upon manipulation or motion. This reaction justified further study of the skeletal system, and the X-ray plates first showed the true nature of the disease. The illustrations appended (Figs. 3, 4, 5) will indicate that the features agree in most details with the osteomalacic complex.

Blood cell and plasma studies gave results within normal limits, only a mild secondary anæmia being evident. Calcium 12.5 milligrams per 100 cubic centimeters; phosphorus, less than 2 milligrams per 100 cubic centimeters; carbon dioxide, whole blood, 44 volume per cent at 40 millimeters pressure carbon dioxide; carbon dioxide true plasma, 48.8 volume per cent at 38 degrees centigrade; oxygen capacity, 17.5 volume per cent; cell volume 37.95 volume per cent; sodium chloride, plasma 6.411 grams per liter.

Under the administration of cod-liver oil and a high caloric diet, the patient's condition showed slight general improvement up to the time of discharge on the seventeenth day, but the functional capacity of the limbs was still practically negligible. She was allowed to return home under strict regulation of activity, diet, and medication. The diagnoses on discharge were (a) osteomalacia; (b) syphilis; (c) rickets (healed); (d) rheumatic heart disease with mitral stenosis and insufficiency, and aortic insufficiency; (e) syphilitic aortitis (?).

The child's history was of little additional significance. At birth the weight was 2,930 grams, and the general physical examination showed wholly normal findings. X-ray examination of the wrists showed suggestive early rachitic changes. Blood count: red blood cells 3,912,000; hæmoglobin 75 per cent, white blood cells 7,100 (polymorphonuclears, 36 per cent; mononuclears 59 per cent—slight acromia in stained smear). Blood Wassermann, negative in the alcoholic antigen, 4+ in the cholesterinized. Chemical studies of the blood showed calcium 9.8 milligrams per 100 cubic centimeters; phosphorus 5.7 milligrams per 100 cubic centimeters. Chemical and microscopic examination of the milk yielded nothing of significance. Breast feeding was used exclusively and the weight on discharge at the end of 4 weeks was 3,360 grams. Repeated observations and examinations were arranged for both mother and child.

In conclusion it is of interest to state that the patient in question is now 2 months advanced in her second pregnancy. Repeated X-ray examinations show at the present time some evidence of bony repair. The general condition is satisfactory. She is registered in our prenatal clinic and delivery at term will be executed by cæsarean section followed by hysterectomy and bilateral salpingo-oöphorectomy.

SUMMARY

1. The literature of osteomalacia has been briefly reviewed. In addition statistical and experimental evidence has been quoted which leads to the belief that the prophylaxsis and cure of this syndrome lies largely in the problems of dietary deficiency and vitamine balance.

2. The detailed history of a patient with puerperal osteomalacia is reported, including X-ray studies which reveal the bony changes characteristic of this disease. The occurrence of the latter in a geographical locality where such lesions are rarely seen calls to mind the assertion that the disease may be more common than is generally supposed.

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THE EARLY RECOGNITION OF ACUTE PERFORATION OF GASTRIC AND DUODENAL ULCER BY X-RAY EXAMINATION OF SPONTANEOUS PNEUMOPERITONEUM[1]

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FREE gas in the peritoneal cavity has long been recognized as a phenomenon occurring in perforations somewhere in the gastro-intestinal tract, and most frequently after perforation of a gastric or duodenal ulcer. The clinical demonstration of this free peritoneal gas is usually accomplished by *percussion of the liver dullness* in that a diminution in size of the normal area of liver dullness is considered as evidence of free air within the abdomen. This sign is usually considered to be of greater significance if the zone of tympany over the liver can be made to shift in location by changing the posture of the patient (Ortner, 10).

Not all cases of acutely ruptured gastric and duodenal ulcer show this sign, especially in the earliest stages of acute perforation. The *incidence of the sign on percussion* varies so much with the duration of the perforation, the quantity of air which has escaped into the free peritoneal cavity and the difficulty of percussing properly a very tender and rigid abdomen that some observers attach but slight importance to the possibility of demonstrating free air in the peritoneal cavity by the ordinary means of physical examination, especially during the earlier stages of the perforation (C. L. Gibson, 8; A. D. Bevan, 4; W. R. Cubbins, 6).

Our attention was attracted to the possibility of using the *X-ray to demonstrate free gas in the peritoneal cavity* following a rupture somewhere in the gastro-intestinal tract. A few observations on the use of the roentgen-ray in the recognition of free and encapsulated gas in the peritoneal cavity have been reported by several authors. R. Reinecke (12), reported a case of perforated, gangrenous appendicitis which was followed by the development of a subphrenic abscess. X-ray examination of the abdomen revealed a zone of air between the right half of the diaphragm and the upper surface of the liver. This zone of air was seen when the patient was in the upright position and disappeared when the patient was placed on his back. We have examined a considerable number of patients with acutely perforated appendices but without the formation of subphrenic abscess but were unable to demonstrate free gas in the peritoneal cavity. Alwens (1) found a similar picture in a subphrenic abscess following a ruptured duodenal ulcer. L. Kenez (9) observed the same phenomenon in a case of perforated tuberculous ulcer of the bowel where there were no other clinical signs of perforation such as pain, muscular rigidity, chills, or marked meteorism. The X-ray revealed a zone of gas between the liver and right diaphragm and was the only clinical evidence of the perforation found at autopsy. The sign was further observed by H. Popper (11) in a case of perforated ulcer of the intestine in which the diagnosis was proved by anatomical demonstration.

The observation with the X-ray of free gas in the peritoneal cavity after perforation of a gastric or duodenal ulcer has been reported by B. Bager (3), H. Schottmuller (13), H. A. Dahm (7), W. Weiland (14), and H. Wessler and L. Jaches (15). These authors reported but few cases while H. Assmann (2), who described the largest number, reported a series of 4 cases very briefly in which air was seen with X-ray after ruptured gastric or duodenal ulcer.

In a series of fifteen anatomically proved cases of *acute perforation* of gastric and duodenal ulcers admitted to the surgical services

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Read before the Chicago Surgical Society, March 7, 1924.

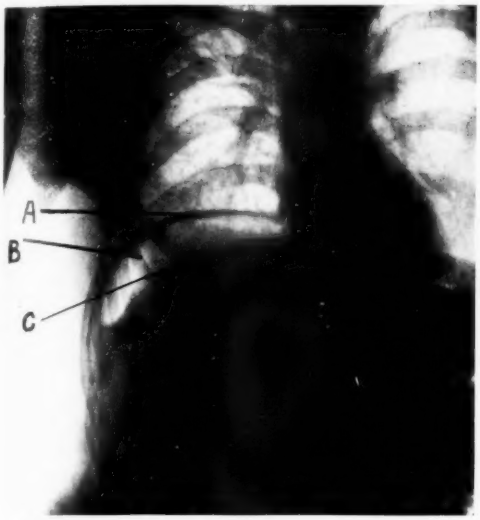

Fig. 1. X-ray plate of patient in the upright position showing *A*, dome of right diaphragm; *B*, free air under diaphragm, *C*, upper surface of the liver.

of the Cook County Hospital of Chicago, an X-ray study was made before operation to determine the presence of free gas in the peritoneal cavity. The X-ray examination was performed in all of these cases as soon as possible after admission, and in some instances as early as 2 to 3 hours after the perforation occurred. This series of cases is of further value because the diagnosis based on the clinical and X-ray evidence was checked up in all instances by immediate operation.

The method employed requires no preliminary preparation or the use of a contrast meal. The patient is brought to the fluoroscopic laboratory and placed under the screen. The fluoroscope furnishes all the necessary information and has the additional advantage of being rapid and at once giving the desired information without waiting for the developing of the films. Films are of value only when permanent records are desired but do not give any information which cannot be obtained by fluoroscopy. The patient may be placed in a standing or sitting position and a rapid examination is made of the entire abdomen and especially just under the diaphragm and between it and the upper surface of the liver. The characteristic, narrow, sickle-shaped zone of air to be described later in greater detail may be seen most frequently just under the right cupola of the diaphragm when the patient is in the upright position. An important characteristic is the fact that *the location of the gas bubble shifts when the position of the patient is changed*. The gas bubble tends to assume the uppermost regions of the abdominal cavity, hence it is found under the diaphragm when the patient is in the upright position; between the right abdominal wall and the axillary surface of the liver when the patient is placed on his left side, and it may be moved to the left side if the patient is turned on his right side. We were able to shift the gas bubble to the pelvis in one of our cases by placing the patient in the Trendelenburg position. Examination of the patient when he is again on his back shows that the gas bubble disappears from between the right diaphragm and the upper surface of the liver or other regions where the air space was seen before the patient was placed on his back. The screen may be placed at the side of the patient when he is in the supine position and the gas bubble may often be seen to occupy the space between the anterior abdominal wall and the viscera.

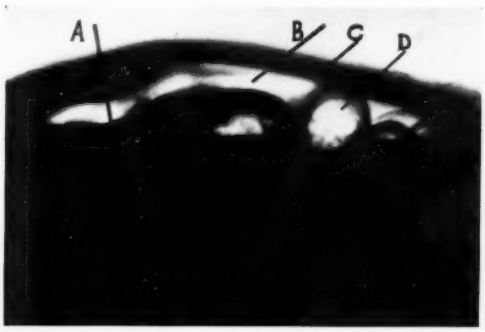

Fig. 2. X-ray plate of patient in supine position showing *A*, level of fluid in free abdominal cavity; *B*, free air in abdominal cavity above the fluid level; *C*, anterior abdominal wall; *D*, loop of bowel containing air.

The appearance of the gas bubble within the peritoneal cavity is quite characteristic and will seldom be mistaken for other things. The gas bubble, as already stated, assumes a narrow sickle shape, is very bright and dis-

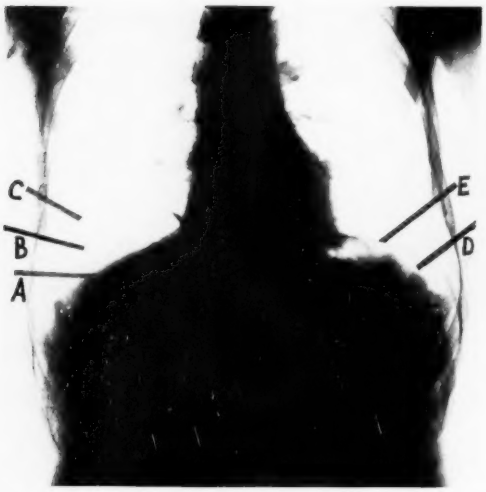

Fig. 3. X-ray plate of patient in upright position showing free air under left and right domes of the diaphragm. *A*, upper surface of the liver; *B*, free air under right dome of the diaphragm; *C*, right dome of the diaphragm; *D*, free air under left dome of the diaphragm; *E*, left dome of the diaphragm.

tinct with no mottling of its body and the boundaries are usually regular and constant in configuration. The most characteristic picture is seen when the air bubble is seen under the right cupola of the diaphragm. The widest part is seen to be in the middle portion while the ends approach one another until the upper margin, which is more curved, meets the lower boundary close to the external

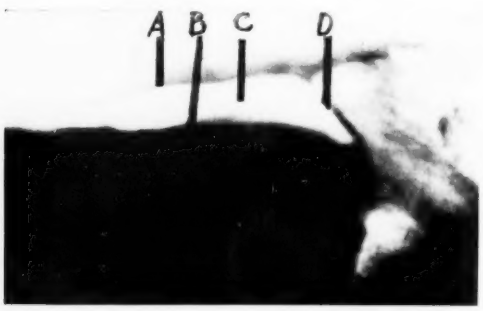

Fig. 5. X-ray plate of patient resting in supine position showing *A*, anterior abdominal wall; *B*, upper level of free fluid in the abdominal cavity; *C*, free air in the abdominal cavity between the free fluid and anterior abdominal wall; *D*, diaphragm.

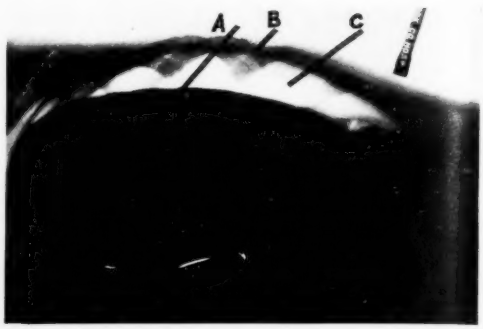

Fig. 4. X-ray plate of patient resting on his left side showing *A*, external surface of right side of liver; *B*, right side of chest; *C*, free air between right side and right surface of the liver.

abdominal wall on one side and the midline of the body on the other. The width of the zone of air depends on the quantity of air which escapes into the free peritoneal cavity but the presence of free gas in the abdominal cavity is always very distinct regardless of the quantity. The line at the base depends on the nature of the viscera at this region or on the presence of fluid but is usually more or less of a straight line. The lower boundary is very straight and horizontal regardless of the position of the patient if the inferior boundary is formed by an accumulation of fluid and further evidence of the presence of air and fluid may be obtained by shaking the patient when it will be observed that the dependent dark boundary may be made to assume a wavy outline or may be seen to splash.

No patient is too ill for this examination as the upright position is not necessary. In fact, most of our examinations were made with the patient on a cart and first on his back and then on his left side in order to demonstrate the presence of the air bubble between the right abdominal wall and the axillary surface of the liver after previously noting its absence in this region while the patient is still on his back. It is seldom necessary to turn the patient on his right side and it is only when the patient is in a comparatively good condition that he need be made to sit up on the cart or table.

The sign as just described was sought for in our series of 15 cases of anatomically proved

acute perforation of gastric or duodenal ulcer and found in thirteen instances or in 86.7 per cent. We were unable to see the same phenomenon in other conditions which are usually considered as acute surgical conditions except in one instance of acute perforation of an ulcer of the small intestine. The value of the sign for the surgeon is not diminished by the finding of free air in the peritoneal cavity following a perforated ulcer of the small bowel as it was a great help in the diagnosis which was a surgical emergency and required immediate operation.

The following résumé is a brief description of the clinical histories, results of X-ray examination and operative findings, together with the results of operation in the 13 cases of acute perforation of gastric ulcer in which the sign previously described was found before operation.

CASE 1. O. B., male, age 56, admitted on October 22, 1921. Complained for one year of burning, epigastric pains 1 hour after meals and relieved by soda or food. Pain was very severe in the last 2 weeks and especially on the day of admission. Hæmatemesis and occasionally bloody stool in last 2 weeks. The acute exacerbation occurred 7 hours before admission to the hospital. Examination showed marked epigastric tenderness and rigidity and the patient was doubled up with pain. The white blood count was 8,700 and the temperature normal. Fluoroscopic examination revealed a zone of distinctly free air between the diaphragm and the upper surface of the liver. The free air shifted in location on change of posture of the patient. The patient refused immediate operation for more than a day after admission. Operation then revealed a large, perforated ulcer, midway between the pylorus and cardia and with free fluid in the peritoneal cavity. The patient died the day after the operation.

CASE 2. J. R., male, age 25, admitted to hospital November 17, 1922. Sudden onset with sharp, severe, epigastric pain 3 days before admission. Attack occurred while walking. No previous digestive disturbances were noted. Vomiting and prostration were present at the time of admission. Marked tenderness and rigidity of upper abdomen, temperature 98 degrees, white blood count 10,600, urine contained a trace of albumin. Liver dullness was diminished on percussion. Fluoroscopic examination revealed the presence of free gas in the peritoneal cavity which shifted on change of posture of the patient. Operation revealed a perforated gastric ulcer on the anterior surface, 6 centimeters from the pylorus. The patient recovered and was discharged as cured on December 2, 1922.

CASE 3. J. A., male, age 31, admitted to hospital on October 20, 1922. Complained for last 6 weeks of abdominal pain after meals with relief on taking soda. Acute onset with sudden, sharp, epigastric pain 5 hours before admission. No vomiting. Diffuse tenderness and rigidity of the abdomen, especially of the right side. Liver dullness diminished on percussion. Temperature 98 degrees, white blood count 24,000, urine negative. Fluoroscopy showed a bubble of free air in the peritoneal cavity which shifted on change of posture. Operation revealed a pin-point perforation of the stomach on the lesser curvature and about 2 centimeters from the pylorus. The patient was discharged as cured on November 2, 1922.

CASE 4. F. G., male, age 28, admitted to hospital on January 30, 1922. Complained of epigastric oppression after meals and vomiting for last 4 weeks. Relief with alkalies. Sudden onset with severe pain while at work 9 hours before admission. Diffuse tenderness and rigidity of abdomen, temperature 99.6 degrees, white blood count 17,000, urine negative. Liver dullness diminished on percussion. Fluoroscopic examination showed a bubble of free air within the peritoneal cavity which shifted on change of posture. Operation revealed a perforated gastric ulcer. Patient discharged as cured on February 19, 1922.

CASE 5. F. S., age 39, male, admitted September 5, 1923. Was ill for 2 weeks with dull epigastric pain 15 minutes after eating. Sudden, acute, abdominal pain 4 hours before admission, causing patient to double up. Marked tenderness and rigidity, especially in upper abdomen. Liver dullness diminished on percussion. Temperature 99.7 degrees, white count 10,600. Fluoroscopy revealed a definite zone of air between the diaphragm and upper surface of the liver and shifting of the air occurred on change of posture. Operation revealed a perforated gastric ulcer at the cardiac end of the stomach. The patient was discharged as cured on September 24, 1923.

CASE 6. R. F., male, admitted on September 24, 1923. Very ill for several days and took drastic purgatives for 2 days. The symptoms suddenly became worse about 13 hours before admission with severe, epigastric, crampy pains and constipation. Marked tenderness and rigidity of the abdomen, temperature 97 degrees, urine negative, white blood count 12,600. Fluoroscopy revealed a zone of free peritoneal gas between the diaphragm and liver. Change of position of the patient caused the gas bubble to disappear from the before mentioned location. Operation revealed a small perforated gastric ulcer at the lesser curvature with free fluid in the peritoneal cavity. The patient died of a diffuse peritonitis on October 6, 1923.

CASE 7. J. L., male, age 26, admitted on February 18, 1923. Ill for 2 weeks with pain in the epigastrium 1 to 2 hours after meals and at night. Sudden onset 4 hours before admission with severe, acute abdominal pain but with no vomiting. Marked,

diffuse tenderness and rigidity of the abdomen, liver dullness diminished on percussion and the right side of the rectum tender on digital examination. Temperature 98 degrees, urine negative, white blood count 21,000. Fluoroscopic examination showed a very narrow but distinct zone of air between the upper surface of the liver and the diaphragm. The gas bubble disappeared on change of posture. Operation revealed a perforated gastric ulcer on the lesser curvature near the pylorus. Patient discharged as cured, March 4, 1923.

CASE 8, J. C., age 42, admitted to hospital on January 2, 1923. No previous digestive disturbances. Sudden onset with severe abdominal pains 4 hours before admission and following a breakfast of pickles and tomatoes. Constipation and vomiting also occurred. Examination revealed marked, diffuse tenderness and rigidity of the abdomen but especially near the gall-bladder region. *No definite diminution of the liver dullness could be elicited on physical examination.* Temperature normal, urine negative, white blood count 14,700. Fluoroscopic examination showed a definite zone of free air in the right upper quadrant of the abdomen just under the diaphragm. The zone of air shifted with change of posture of the patient. Operation revealed a perforated gastric ulcer on the lesser curvature of the stomach near the pylorus. The patient was discharged as cured on January 17, 1923.

CASE 9. J. V., age 50, admitted to hospital on September 26, 1923. Epigastric distress after meals for past 6 months with relief after food, soda, and vomiting. The condition became more severe 3 months ago and was diagnosed as ulcer. The present attack occurred 15 hours before admission while the patient was asleep. There was very severe epigastric pain but no vomiting and the patient took a large saline purge but without effect. Examination showed a uniformly distended, tense, tender, and rigid abdomen and most marked in the epigastrium. The liver dullness was diminished on percussion but the overlying zone of tympany could not be made to shift on change of posture of the patient. The temperature was normal, the urine contained considerable sugar but no albumin and the white count was 22,600. Fluoroscopic examination showed a zone of air between the right abdominal wall and the lateral surface of the liver with the patient lying on his left side and a shifting of this zone of air to a place just under the diaphragm and above the liver when the patient was placed in the upright position. The lower margin of this zone of air could be seen to splash on shaking the patient showing that fluid as well as air was present. Operation revealed a perforated gastric ulcer on the lesser curvature with diffuse peritonitis. Death occurred on September 30, 1923.

CASE 10. H. D., admitted to hospital May 20, 1923. Had epigastric pain 1 hour after meals for the last 15 years. Relief after food, soda and vomiting. The pain became worse during the last 3 weeks and occurred almost immediately after meals. A very severe, epigastric pain occurred about 3 hours before admission and was followed by vomiting 2 hours after the onset. The epigastrium was tender and the entire abdomen was rigid. The liver dullness was diminished on percussion and the white blood count was 15,700. Fluoroscopic examination showed free air in the peritoneal cavity which could be made to shift on change of posture of the patient. Operation revealed a ruptured gastric ulcer on the lesser curvature near the pylorus. The patient was discharged as cured on June 13, 1923.

CASE 11. F. S., admitted to hospital, March 23, 1923. The patient had epigastric pains a half hour before meals for last 6 months with relief by food or vomiting. Sudden, severe, epigastric pain with hæmatemesis 2 hours before admission. Marked, diffuse tenderness of the abdomen. Liver dullness slightly diminished on percussion. Dark brown material vomited during examination. Temperature 97 degrees, urine contained a trace of albumin, white blood count 15,000. Fluoroscopic examination showed a distinct zone of air between the liver and diaphragm, while in the upright position, between the external abdominal wall and the lateral surface of the liver when he was on his left side and between the viscera and anterior abdominal wall when the patient was on his back. A wave like contour of the inferior margin of the air bubble could be demonstrated when the patient was shaken showing the presence of air as well as fluid in the abdominal cavity. Operation revealed a ruptured gastric ulcer with free fluid in the abdominal cavity. The patient was in very poor condition when admitted and died on March 29, 1923.

CASE 12. J. S., admitted to hospital, June 3, 1923. Digestive disturbances for past 10 years. The present attack came on 7 hours before admission with sudden, severe pain below the umbilicus and radiation to both thighs. Constipation, nausea and vomiting for 24 hours previous to the time of admission. Diffuse abdominal tenderness and rigidity and especially in the lower right quadrant. Liver dullness diminished on percussion. Temperature 96.6 degrees, urine negative, white count 8,150. Fluoroscopic examination showed a definite gas bubble between the right abdominal wall and lateral surface of the liver when the patient was on his left side. Further examination was considered unnecessary in view of the findings on X-ray and the poor condition of the patient. Operation revealed a large, perforated gastric ulcer on the anterior surface and near the pylorus. Death occurred shortly after the operation was completed.

CASE 13. R. H., male, age 26, admitted to hospital September 4, 1922. Ill for about 1 month with crampy pain about the navel 1 hour after meals and lasting 2 to 3 hours. The present attack began 24 hours ago with sudden, severe, crampy pains over the entire abdomen and becoming localized around the umbilicus in 2 hours. Vomited three times. Examination showed an acutely ill patient, temperature 102.2 degrees, pulse 144, respirations 40 per

minute. The entire abdomen was tense and rigid, especially near the navel. The right scrotum was tender, hard and swollen and could not be reduced so that a strangulated inguinal hernia was suspected. Rectal examination was very painful but showed nothing of importance. Urine negative, white blood count, 12,600. Fluoroscopic examination revealed the presence of free air in the peritoneal cavity and this sign at once cleared up the diagnosis. Operation revealed a perforated duodenal ulcer with free fluid in the peritoneal cavity. The patient was discharged as cured on September 21, 1922.

A study of our series of cases shows that the presence of free air in the peritoneal cavity after an acute perforation of a gastric or duodenal ulcer was easily and distinctly demonstrated in 13 of 15 cases of anatomically proved ruptured ulcer. This makes an incidence of 86.7 per cent. It was also shown that the gas bubble resulting from the escape of free air into the peritoneal cavity may be seen as early as 2 hours after rupture of the ulcer. The quantity of escaped air need not be very large before it can be visualized with the X-ray as it all tends to collect in one place in the uppermost portion of the abdomen and becomes easily visible especially between the liver and diaphragm or between the liver and the lateral abdominal wall. The air space is seen as a very bright area which is limited by very dark structures such as the liver, diaphragm, or abdominal wall. It must be added, however, that air must be present in the stomach at the time of, or after, the acute perforation occurs in order that free air in the peritoneal cavity be found in the earlier stages. The air which is normally contained in the upper part of the normal or diseased stomach and which is usually present in the stomach as a result of the act of swallowing may be sufficient to furnish enough air to be visualized by X-ray after the air has escaped through the perforation into the free peritoneal cavity. One of our patients in whom free air could not be demonstrated in the peritoneal cavity after acute perforation of a gastric ulcer showed an absence of the air ordinarilly seen in the stomach—known as the *magenblase*.

The sign is of further value because *it enables us to make a more early as well as a more positive diagnosis*. The importance of an early diagnosis and immediate surgical treatment in acute perforation of a gastric or duodenal ulcer need hardly be mentioned in this paper. It is a well known fact that the mortality rises rapidly with the number of hours which elapse before surgical treatment is instituted. This feature is well illustrated by dividing our series of cases into two groups; one in which the patients were operated upon within 12 hours after the perforation occurred and another group in which the operation was not done until 12 or more hours elapsed after the rupture. In the group operated upon before 12 hours had elapsed there were 6 recoveries and 3 deaths, making a mortality of 33 per cent, while in the group operated upon more than 12 hours after rupture, 2 recovered and 2 died, making a mortality of 50 per cent.

The finding of free gas in the peritoneal cavity on X-ray examination may also be of value in the very early stage of ruptured peptic ulcer before a complete clinical picture has had time to develop or when the history is indefinite or of such a nature as to cloud the correct interpretation of the clinical signs. A case of this kind came to our attention when a patient who had been on an alcoholic debauch for 10 days suddenly became acutely ill with a severe cramp in the abdomen and with tenderness and muscular rigidity of the abdominal wall. The findings were somewhat suggestive of a perforative peritonitis but the history caused some doubt as to the possibility of the existence of a perforated peptic ulcer. Fluoroscopic examination in the sitting posture at once revealed a very narrow but distinct zone of air under the diaphragm and above the liver. The liver dullness was not definitely noted as diminished on percussion. The findings on X-ray examination led to a decision to operate at once and a perforated gastric ulcer was found. The entire procedure in the X-ray laboratory took less than 5 minutes and was practically without discomfort to the patient.

There are a few conditions which must be differentiated from the zone of air seen on X-ray examination after a perforation of a gastric or duodenal ulcer. Among these are ptosis of the liver with the colon intervening between the liver and the diaphragm as

described by D. Chilaiditi (5). This condition is seldom seen but is differentiated, when present, by the fact that the air space is chiefly in the lateral half of the space between the liver and the diaphragm instead of the entire length of the space and further by the fact that the air is not stationary but is changed in shape and configuration by the peristaltic movements of the colon. The density of the air within the colon is not homogeneous, and the haustral markings may usually be seen. Intracolonic air does not move on putting the patient in a different position and a barium enema may be used in cases where there is doubt as to the location of the air. Certain other gas collections in the abdomen must be differentiated from that resulting from perforated peptic ulcer. These are artificial pneumoperitoneum previously induced for some diagnostic purpose and gas-containing subphrenic abscess. The normal gas bubble ordinarily found in the stomach and diaphragmatic hernia must be differentiated from free intraperitoneal air on the left side. Another condition which must be kept in mind, especially when examining the patient from the lateral aspect and when he is in the supine position, is the presence of a funnel chest which may give a false picture of air in the uppermost region of the abdomen close to the diaphragm. This is caused by the depression in the middle portion of the lower thorax apparently forming the base of an air bubble while the more prominent mammillary parts of the chest closely simulate the upper boundary of the air space. This apparent resemblance can easily be detected by examining the patient after he is on his left side when it will be seen that the air bubble disappears and does not shift to the region which is uppermost by this change of posture. This condition may also be recognized by placing the finger or a piece of metal in the groove of the funnel chest.

RÉSUMÉ

1. Free gas in the peritoneal cavity was found on X-ray examination in 13 of 15 cases, or in 86.7 per cent of anatomically proved *acute perforation* of gastric or duodenal ulcer and is rarely seen in any other condition which can be confused with perforated peptic ulcer.

2. The free gas has been seen *as early as 2 hours after the acute perforation occurs*, and but a small quantity of air is necessary for its demonstration. In some cases the gas bubble is seen with the X-ray before the liver dullness is noted as appreciably diminished on percussion.

3. The presence of free air in the peritoneal cavity is demonstrated *by observing a clear, distinctly bright zone which shifts on change of posture of the patient.* The outline of this zone of air will be determined by the location of the gas bubble and by the nature of the structures which limit it. The most typical picture is seen when the patient is in the upright position. The air bubble then assumes a narrow but very distinct sickle shape and disappears on change of posture. It is not necessary, however, to place the patient in the upright position as a sufficiently characteristic picture may be obtained by placing the patient on his left side and observing the air bubble between the external abdominal wall and lateral surface of the liver. The entire procedure may be performed with the fluoroscopic screen and with the patient still on the cart.

4. The fact that the air is free may be demonstrated by changing the posture of the patient, when it will be observed that the *gas bubble seeks the uppermost portion of the abdominal cavity.* This shifting of the zone of air on changing the posture of the patient is easily demonstrated. The gas bubble is seen under the right diaphragm when the patient is in the upright position. It is seen on the right side between the lateral abdominal wall and the axillary surface of the liver when the patient is lying on his left side, and may be made to shift to the left side of the patient by turning him on his right side.

5. The sign is of great value because it makes possible an *early and definite diagnosis* without danger or discomfort to the patient. The examination is easily and rapidly performed and requires no preliminary preparation of the patient. Fluoroscopy gives all the necessary information and plates are of value only when a permanent record is desired.

6. The presence of free air in the peritoneal cavity on X-ray examination is a very important diagnostic sign of acute perforation of a gastric or duodenal ulcer. It must not be used alone in determining a diagnosis but in combination with other signs and symptoms, as it is only a valuable addition to the clinical syndrome produced by acute perforation of a peptic ulcer. In fact, the diagnosis of perforation can usually be made on the history and physical findings and without X-ray examination but it is well to keep in mind that the sign on X-ray examination as previously described is almost pathognomonic of an acute perforation of the gastrointestinal tract which, in the vast majority of cases, is in the stomach or duodenum.

7. Earlier operation is possible as a result of the earlier diagnosis which this added method of examination makes possible. The earlier recognition and prompt surgical treatment will lower the mortality rate of acute perforation of gastric and duodenal ulcer.

This paper is an elaboration of a report read before the Missouri Valley Medical Association in June, 1922, at Sioux Falls, South Dakota, and was written before but appeared after the article on "Demonstration of Spontaneous Pneumoperitoneum by the Roentgen Ray" by G. H. Copher appeared in the Journal of the American Medical Association, 1924, lxxxii, 781.

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REPORT OF A GASTRO-ENTEROSTOMY FOR RELIEF OF CHRONIC PYLORIC STENOSIS WITH SPASM DUE TO ANEURISM OF ABDOMINAL AORTA[1]

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OCHSNER and SMITHIES (1) in 1916, mentioned aneurism of the abdominal aorta as the last of various causes of benign pyloric stenosis. After the operation in the case reported, I wrote to Dr. Ocshner asking him if he had operated on any cases of this kind. He replied that he had not. In a rather extensive though hurried search of the literature I failed to find a report of anyone who had thought well of this operation for the relief of pyloric stenosis due to anuerism. One of my assistants in the operation counseled that a gastro-enterostomy would not be of benefit. I am very frank to confess that I am somewhat at a loss to understand just how the operation I did affords the man such complete relief.

CASE REPORT

Case S7786, Mary Gates Hospital. E. G., male, 57 years of age, entered the hospital, January 18, 1922, with the following history: He was born in Germany; has had the usual diseases of childhood; denies any knowledge of venereal infection; came to this country when about 20 years of age; is married. His wife is in excellent health. He has two daughters, aged 16 and 18, both very healthy; no children dead. His wife has had no miscarriages. Patient's health has always been good until 5 years ago when he had a light stroke of paralysis, affecting his left arm and leg. He was in bed for a week or more, but returned to work in about 5 or 6 weeks, with slight embarrassment in the use of his arm and leg for several months following. He has had some mental disturbances ever since the hemiplegia. He seems perfectly normal at times, but at other times, knows that he is unreasonable, fractious, and unruly. He has been away two or three times in the summer in an endeavor "to boil out" and improve his general nervous debility. Before his illness, 5 years ago, he drank freely of beer but very little whiskey. For past 5 years, he has drunk very little of anything.

For last 6 months he had noticed some distress in the stomach after eating a hearty meal or drinking a large amount of milk or water. This gradually became worse, although he began to reduce his food in amount on account of the distress. Pain occurred immediately after taking food, and for the last 3 months has become so intense that he has eaten hardly anything solid. The pain was located in th epigastrium, and was accompanied by a choking sensation. Relief followed vomiting, which occurred at times, or a hypodermic injection of morphine and atropine. These symptoms continued to get worse until now he cannot take nourishment, even liquids, without experiencing severe and lancinating pains in the epigastrium, almost always accompanied by a choking sensation. If relieved by morphine, he sometimes vomits food which he had taken the day before. For the last 3 or 4 days, he has suffered almost constantly and has had hiccough for the last 48 hours. He has no cough at any time, and so far as he knows, no fever. He has lost a great deal of weight, estimated at 25 per cent. Very careful questioning of patient and family reveals no evidence that patient has ever vomited blood, or has had any blood in his stools. He was in this hospital 3 days ago, January 15, for laboratory examination.

Physical examination. Small, poorly nourished man; apparently 65 years old. Patient looks emaciated and somewhat anæmic. He appears to be suffering and is quite restless. Head, mouth, throat, and thorax are negative. Diaphragm excursion, apparently embarrassed and limited, though equal on both sides. The abdomen is quite rigid and retracted over entire epigastrium. No point of tenderness can be determined. The lower abdomen is somewhat relaxed. No tympany; no mass can be felt in the epigastrium, although the pulsation of the abdominal aorta is transmitted to the palpating hand over a broad area and is unusually distinct. Auscultation shows a bruit over the epigastrium though not clearly defined.

Laboratory report. Blood: hæmoglobin 65 per cent; red cells, 3,800,000; no leucocytosis. Wassermann, four plus. Urine, trace of albumin; specific gravity, 1012; occasional hyaline casts.

Roentgenograms taken at 1 hour, 2 hours, 4 and 6 hours, after barium meal, all show stomach filled down to pyloric end. Pylorus does not fill, and, 6 hour picture shows a very little has passed into the duodenal cap. There is a suggestion of a mass in the stomach, extending upward toward the diaphragm. This is not clearly determined. It was hard to keep this patient still and the pictures are not as clear as could be desired.

Diagnosis. (1) Ulcer of lesser curvature at pyloric end of stomach, with chronic stenosis, possibly malignant. (2) Chronic pyloric stenosis with intense pylorospasm due to aneurism of abdominal aorta.

Consultation with the attending physician, who had the laboratory examinations made, and who had treated this man for 2 or 3 weeks, developed that

[1] Read before the Texas Surgical Society, San Antonio, Texas, October, 1922.

tincture of belladonna, atropine, and other drugs had been used, together with strict advice as to rest in bed, diet, etc., with no improvement, but on the other hand, the patient was rapidly growing worse. It is unfortunate in the extreme and we very much regret that we were unable to control this patient and make further flouroscopic and roentgenographic investigation in order to arrive at a more definite diagnosis, but the man suffered so intensely and was so starved, together with, at times, almost total lack of reasoning capacity, that exploratory operation was decided upon, as soon as patient could be gotten in a little better condition. After 24 hours of preparation, with constant Murphy drip of 6 per cent glucose, 3 per cent bicarbonate soda, operation was done. Under ether anæsthesia, an incision from ensiform to umbilicus just to the right of midline was made. The stomach came into view easily. No adhesions were present. Lifting the stomach well forward, a most careful examination was made, and failed to show any evidence of an ulcer. Pylorus was normal, but with thickened wall which admitted the tip of index finger on stomach side; a mass which pulsated in all directions, was felt behind the stomach, extending from upper border of pancreas to the diaphragm; further examination, showed it to be an aneurism of the abdominal aorta. Its walls were thick and not easily compressible, although slight pressure only was made on it. It measures, to the feel of the hand, about 7 inches in circumference and about 2½ inches in diameter. It is almost symmetrical in shape, being a little larger at about its middle, and is, therefore, an intramural, cylindrical type aneurism, with thickened walls. Replacing the stomach shows immediately the effect of the direct pressure of the aneurism against its posterior walls. The gall bladder is thin walled, empties easily, and no stones can be felt. The appendix is free and movable, with no adhesions. No other pathology, except the aneurism and the thickened stenotic pylorus, can be determined. Gastro-enterostomy was done as a possible means of relieving the pyloric stenosis and spasm. Abdomen closed in the usual way, without drainage. Time of operation 55 minutes. The postoperative course was not unusual and convalescence was uneventful. There was some nausea, with vomiting once or twice, in the first 24 hours. Barley water was given freely after 24 hours; liquid nourishment freely after 48 hours. Hiccough, rather severe for first 48 hours, subsided entirely after third day. Pain on swallowing water, barley water, etc., for first 48 hours about as severe as before operation, but was entirely relieved after 48 to 60 hours. Vomiting occurred occasionally up to the fifth day, after which time he began taking soft food and made an uneventful recovery. He left the hospital on the twelfth day subsequent to the operation. An endeavor was made, of course, to keep this man in bed, when he returned home, which was unsuccessful. He returned to duty 4 weeks after the operation, as timekeeper in an industrial plant, which job he has continued to fill without losing any time from his work.

October 3, 1922. Patient's wife states that he has regained his normal weight, that he eats freely of everything he wants, in spite of her efforts to restrict his diet, and that he has no digestive disturbances.

January 26, 1924. Information today is that patient continues to enjoy good health; has had no medication or restriction in diet since his operation.

It was my opinion at the time of operation, that gastro-enterostomy with a large stoma at the most dependent portion of the greater curvature of the stomach, as near the pylorus as possible, would give relief to the terrible pylorospasm that this man had; that this, in turn, would check the constant and violent peristaltic waves occurring on the intake of food or water into the stomach, and, would therefore relieve the excruciating pain, and, at the same time permit the assimilation of proper nourishment. We all know that once a constant and continuous spasm of the pylorus occurs, from any cause, it is cumulative in its action and has a tendency to produce hypertrophy; that the pyloric sphincter will become stenosed by the constant activity of the circular fibers responding to the stimulus causing this spasm. As a result of this, there is a reverse peristaltic wave, and unless the patient vomits, back again goes the wave with its attendant pain, to the pylorus. A gastro-enterostomy, affording a good outlet to the stomach, should soon allay the pyloric spasm and peristaltic wave, and the patient should be relieved, at least temporarily. It is not thought that a pyloroplasty of any kind would serve quite as well as the gastro-enterostomy with a large stoma. The slightly pulling downward of the stomach may have displaced the organ somewhat below the aneurism and in that way helped some, although the displacing of the stomach does not occur to me as sufficient to do much, if any, good, as the aneurism extended up to the diaphragm and really may have been transdiaphragmatic in its origin.

Matas (2) has called attention to this type of aneurism—intramural spiral, or cylindrical, with thickened walls, extending in the aorta, at times, almost any length, even down to its bifurcation. The aneurism causing this trouble was of the abdominal aorta in the main, although it may have originated just above

the diaphragm. The largest part of the sac or the most prominent part of the bulging was about 2 inches below the diaphragm, pressing against the cardiac end of the stomach wall. What damage this aneurism was doing to the solar plexus and surrounding nerves, we cannot say. If one will review in one's mind the anatomy and physiology affected by this aneurism, it may help some in arriving at an understanding of how this man gets his relief.

It is admitted that an ulcer of the stomach may exist, and yet at operation none be found. Finney (3) says he has opened stomachs that had distinct physical signs and symptoms of the existence of an ulcer where he believed one to be present, and yet he has been unable to find one. I was more than careful in this instance to demonstrate an ulcer and palpated most carefully, examining practically every portion of the stomach and free portion of the duodenum by folding the walls on itself, etc., by careful inspection and touch, and by every means known to me for determining the presence of an ulcer, but failed to find one.

CONCLUSION

This was a case of chronic pyloric stenosis, with violent pylorospasm together with cardiospasm and hiccough due to an intramural spiral or cylindrical type of aneurism of the abdominal aorta, extending from, possibly, within the diaphragm to the upper border of the pancreas with constant and excruciating pain and starvation, relieved by posterior short-loop gastrojejunostomy.

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UNRECOGNIZED HÆMORRHAGE WITHIN THE UPPER LEG, RESULTING FATALLY

Four Cases

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THESE cases are reported to call attention to a definite traumatic condition; i.e., hæmorrhage within the upper leg which may go unrecognized and may result fatally.

This is in contradistinction to the frequent traumatic injuries to the upper leg which go on to the formation of hæmatomata of varying degree. It differs also from hæmorrhages with resulting hæmatoma formation in the upper leg caused by penetrating projectiles as seen in the late war, where wounds were explored as soon as possible, with a debridement of all crushed tissue and a ligation of the bleeding vessels.

Billroth[1] early pointed out that in the relatively slight injuries of the thigh, hæmatomata result and that even in the severe crushing injuries of the upper leg, when large vessels are severed, extensive spurting hæmorrhage may not occur, but a slow oozing of blood may be expected.

The cases which are reported in this article indicate that the oozing may go far beyond the formation of a hæmatoma, and the blood may find its way unchecked along muscle and fascial planes and result fatally. The last case recorded shows that the bleeding may not occur as an ooze but as a swift outpouring of blood into the leg, followed quickly by death.

The first time that this condition was noted was on May 23, 1915, when I assisted Medical Examiner Max Scarborough of New Haven to perform an autopsy on G. O., a well developed and well nourished white man of 33 years of age.

During the early evening of the previous day this man had been stabbed in the groin. The instrument used was the typical, long bladed, Italian jack knife. The man was taken directly to St. Raphael's Hospital. His condition was not thought to be serious. There was very little bleeding from the clean cut wound in the groin. A dressing was applied to the wound and patient put to bed. An hour or so after admission the nurse in charge reported to the interne that the patient's condition was not good. The interne examined the patient, who showed the usual symptoms of shock and hæmorrhage. The wound was inspected and found in good condition, and no external bleeding was present. The dressings were reapplied. The symptoms of shock increased without any apparent cause, and 6 hours after the accident the patient died.

The autopsy was performed 12 hours after death. The body was that of a well developed and well nourished, white man, 33 years of age; height 67½ inches, and weight 160 pounds. The skin was very pale. There was very little settling of blood in the dependent portions. General rigor mortis had set in. There was a stab wound of the right thigh situated 6 inches below the superior iliac spine and 5 inches from the pubis. The wound measured three quarters of an inch transversally and five sixteenths of an inch vertically, the latter measurement representing the gaping wound. The direction of the outside wound was parallel with Poupart's ligament. The wound ran almost horizontally backward and slightly inward, to a depth of 2¾ inches.

The lower legs were normal in size and color. The right upper leg showed a uniform enlargement from the knee to the groin. The skin covering the upper right leg was not tense nor did it show any change in color. To external appearance, except for the wound in the groin, the right leg was apparently normal.

When the right upper leg was opened it was found that the knife blade had passed through the skin, fascia, sartorius and recti femoris muscles and skipping the femoral artery and vein, had severed branches of the deep profunda artery and vein. Blood oozing from these severed vessels had followed the fascia planes and had infiltrated between the muscles, so that the whole upper leg was filled with clots of blood and blood serum. No actual measurements were made of the leg or the amount of blood in the leg. Approximately the increase in the mean circumference of the upper leg was about 2½ inches to 3½ inches and the amount of blood present was about 2 quarts.

The rest of the examination was negative pathologically except that the skin, musculature, internal organs, and blood vessels were found to be practically bloodless.

Death was due to hæmorrhage within the upper right leg following a stab wound of the groin.

[1] Die Allgemeine chirurgische Pathologie und Therapie, 1868, p. 157.

The second case was autopsied by me on September 3, 1920, at St. Mary's Hospital, Waterbury, Connecticut.

An Italian, Wm. P., who, while straining at his work, his body musculature tense, had his right foot caught between a girder and a crane and suddenly and forcibly rotated outward. The foot was disengaged and the patient taken immediately to the hospital. The patient complained of pain in the right ankle and upper leg. Examination revealed some deep lacerations over the dorsum of the right foot and fractures of the right tibia and fibula in the lower third. No apparent injury of the upper leg was noted. The lacerations were sutured and drained, only a slight amount of bleeding having occurred. The fractures were reduced and dressing applied. The patient was placed in bed, but did not seem to rally as well as he should, after such a surgical procedure. The pulse and respiration increased and the patient showed the usual signs of shock and hæmorrhage. The surgeon was notified and the dressings on the ankle were inspected. There was some slight blood on the dressings but no active bleeding was present. The dressings were reapplied. Further examination did not elicit any other source of bleeding. The usual remedies for shock were instituted without avail. The patient gradually sank into more profound shock and died 11 hours after admission to the hospital.

The body was that of a well developed muscular Italian, 24 years of age; dark hair and eyes. Teeth were natural and sound. General rigor mortis had set in.

There was a ragged cut over the dorsum of the right foot. The cut edges had been approximated by skin sutures and the wound drained. On dissection a complete fracture of the right tibia and fibula was found in the lower third. There was slight hæmorrhage around the fractures. There was no difference in size of the lower legs.

The color of the upper right leg was apparently normal and the shape was not noticeably different, but when compared with the left upper leg the right was appreciably and uniformly enlarged from the knee to the groin. No actual measurement was made but a fair estimate would be a mean uniform enlargement of 3 inches or more. Palpation of the right upper leg revealed lumpy masses deep in Scarpa's triangle.

Dissection of the upper right leg revealed that the sartorius muscle, which was unusually well developed, had been ruptured in its middle third and the segments completely separated. The adductor muscles had suffered a partial rupture. The blood vessels supplying these muscles had been severed and the blood had oozed out and followed the fascia planes and infiltrated between the muscles. Scarpa's triangle was filled with clots. It was these clots and the severed segments of the sartorius muscle that had been palpated. An estimate of the amount of blood found free in the leg would be conservatively placed at 2 quarts.

The rest of the body did not show anything of note pathologically except a paleness of the tissues and organs and a general bloodlessness.

Death was due to hæmorrhage within the upper right leg following rupture of the sartorius and adductor muscles.

The third case is not as typical as the preceding two for it is complicated by other pathological conditions. This is a frequent type of accident and often ends in death, but I believe that the secondary causes are considered the primary cause of death, and the real primary cause, internal hæmorrhage, is overlooked.

J. R., a white man, 36 years of age, had been brought to St. Mary's Hospital in the police patrol on the night of November 26, 1923. He had been on a drunken spree for 2 weeks and shortly before his admission to the hospital he had engaged in a brawl and had fallen, injuring his right hip. He was quite drunk on admission, very nervous, and complained of pain in the right hip and inability to move right leg.

A diagnosis of fracture of the neck of the right femur was made and the leg was temporarily immobilized in a long lateral splint. During the day a general anæsthesia was administered and a long plaster spica bandage was applied to the leg. At that time no swelling of the leg was noticed. That evening the temperature was 98.8 degrees; pulse 106, and respirations 26. During the second day the patient was extremely restless and irrational; the temperature was 99 degrees; the pulse 106, and respirations 24. During the third day the patient was so irrational that the temperature was not taken. The pulse became increasingly rapid and weak. The respirations were rapid and labored. The patient died 75 hours after admission.

The body was that of an adult white man, well developed and nourished; weight 190 pounds. Dark brown hair and moustache. Teeth were sound. Eyes were gray. The pupils widely dilated but equally so. The skin was clear but very pale. There was very little settling of blood in the dependent portions. General rigor mortis had set in. On removing the cast a black and blue discoloration was noticed beneath the skin high up in Scarpa's triangle, and compared with the left upper leg; the right showed a uniform general enlargement. By actual measurement there was 3¼ inches enlargement in circumference high up in the groin and 2½ inches enlargement in the middle third and 1½ inches enlargement in the lower third. A mean general enlargement of about 2½ inches.

On removing the skin and fascia from the upper right leg, large clots of blood were found filling Scarpa's triangle and infiltrated between the general

musculature. There was a complete intertrochanteric fracture of the femur. The segments were in apposition but the surrounding musculature was badly lacerated. It was evident that the bleeding had come from this torn muscle tissue.

An estimate of the amount of hæmorrhage within this leg would be one and a half quarts.

There were dense dry pleuritic adhesions in both pleural cavities and definite pneumonic consolidation of both the right and left lower lobes of the lungs and congestion of the right upper and middle lobes.

The other pathological conditions found were œdema of the meninges; myocarditis with dilatation of the right auricle; a large fatty liver; toxic splenitis, acute parenchymatous nephritis, and acute gastritis and enteritis. There was about 10 ounces of blood found in the heart but in the other organs the amount of blood found was greatly reduced.

This man was suffering from acute alcoholic poisoning when he sustained the fractured femur. The great loss of blood within the leg, associated with the other pathological conditions, were enough to cause death. The pulse and respiration were typical of shock and hæmorrhage.

The primary cause of death was hæmorrhage within the right upper leg following an intertrochanteric fracture of the femur. The contributing causes of death were hypostatic pneumonia and acute alcoholism.

The fourth case did not come to autopsy but it illustrates the fact that rapid fatal hæmorrhage may occur within the upper leg.

J. McE., a well developed young man, 20 years of age, 5 feet, 11 inches, in height, weight 155 pounds. He was sitting on a girder high up in a foundry when a large iron crane approached him unawares and crushed him against a girder. The man's upper left leg was caught, and could not be extricated, the weight coming on the left iliac bone, and the upper left leg. The rest of the man's body was not injured. It was necessary to burn through the iron girder (1½ feet in thickness) before the man could be freed. This took an hour and a half. During this time the man was conscious and in great pain, relieved by morphine, but his condition was not alarming. Just as soon as the weight was taken from the upper leg the man went into shock and died a few moments later, when he was lowered to the ground.

Examination showed that the man had bled slightly into his underclothes from a cut over the dorsum of his penis but not enough to warrant the symptoms noted.

No other external signs of bodily injury were noted except superficial abrasions of the anterior and lateral surfaces of the left upper leg. The injured left upper leg was definitely larger than the right. Circumference of the right above the knee was 15 inches and of the left 16 inches. At the middle third the right measured 18¾ inches, and the left 19½ inches; in the upper third, the right was 23 inches and the left 24 inches. There was no change noted in the color of the left leg except in the regions of the abrasions.

On palpation a fluid wave was present over and along Scarpa's triangle and in the dependent portions of the left upper leg.

There was a complete but not compound fracture of the left femur in the middle third. On pressure a fracture of the left iliac bone could be elicited.

The general appearance of the body was that of complete exsanguination.

Death was due to fracture of the left femur and iliac bones with acute hæmatoma into the soft parts of the upper leg. The pressure between crane and girder had acted as a tourniquet but, when released, rapid and fatal hæmorrhage within the upper left leg had occurred.

SUMMARY

These cases show:

The possibility of losing enough blood within the upper leg to cause death. Death comes either instantaneously, following the rapid extravasation of blood, or as in the cases of slow oozing, a fatal ending may be prolonged for hours or even days. One might doubt that enough blood could be lost within the leg to cause death, and if that amount of blood were lost within the leg, it would seem impossible to overlook it, but as a matter of fact the general increase in size is very small. Considering an adult's thigh to have a circumference of 23 inches high up in the groin and a circumference of 17 inches above the knee and the distance between these two points being 14 inches, it is possible to compute the cubic contents of this truncated cone. In the third case there was a general increase in the mean circumference to 2½ inches and by computation I find that the increase represents 1,600 cubic centimeters plus of blood and serum.

The condition of hæmorrhage can be easily overlooked unless the injured leg is compared with the uninjured leg.

In cases of death following fracture of the femur, an unrecognized extensive hæmorrhage within the leg may actually be a factor of paramount importance in the fatal issue.

In crushing injuries to the thigh, with or without fracture, with progressive symptoms of shock, a progressive increase in the circumference of the thigh may direct attention to a serious hæmorrhage in the soft tissues of the parts.

FOCAL INFECTION (ELEPHANTIASIS)[1]

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DURING the summer and fall of 1920, our ingenuity was taxed to the utmost in an effort to ascertain the cause of pain and swelling of the entire left leg of a robust appearing young man. He was admitted to the University Hospital with the diagnosis of phlebitis of the left leg.

His complaint was pain in, and swelling of, the left leg, foot, and thigh, and headache, frontal in type. The onset was rather sudden during November, 1917, and had persisted since. The greater portion of the intervening time he had spent in various hospitals, without improvement.

General physical examination was negative except for left leg. The thigh measured 2½ inches larger than the right and the calf 1 inch larger. There was no evidence of varicosity, thrombosis, or phlebitis. The left inguinal glands were a trifle enlarged. Blood counts, cultures, and Wassermann were nega ive. Spinal Wassermann was negative. Repeated searches for filaria were negative. Roentgenograms of leg showed no bony lesions; of head, showed an area of density in the upper outer portion of the left frontal sinus. The urine contained a trace of albumin and a few pus cells, constantly. Catheterization of kidneys August 3, 1920, showed a few pus and red cells from each kidney as well as a coccus infection; functional output normal and pyelograms normal. Both pelves were lavaged with mercurochrome 220. Following this, his pain and swelling promptly disappeared. He was allowed to be up, to go down town and remained free from symptoms for 7 weeks when the pain and swelling returned, and his urine again showed pus, in spite of the fact that he had been receiving large doses of hexamethylenetetramine. October 6, 1920, the kidneys were again catheterized, when, to our surprise, since it had not been present before, chyluria was shown in the left kidney, fat globules of variable size, staining brown with Sudan III. The pelves were again lavaged with mercurochrome 220. Renewed searches were made for filaria, even excising several inguinal glands and examining them, with negative results. The pain and swelling almost but never quite completely disappeared as after the first lavage, and being up, had no influence upon it. He was given three doses of neosalvarsan because of the possibility of filaria, even though we could not find them. November 11, he left to visit his wife, who was ill in Providence, Rhode Island. Soon after arrival, he developed an attack of appendicitis, was removed to the hospital, and operated upon. We lost sight of him until a few months ago when I saw him on a visit to our city and from him learned that, soon after his appendectomy, he had had his left frontal sinus operated upon and that he had had no trouble with his leg since and had been able to work regularly. He had then a lymphangitis with moderate elephantiasis of left leg, recurring pyelitis, bilateral, and left frontal sinusitis.

Can we say that the probable course of development was first a frontal sinusitis with a toxic lymphangitis of his left leg and that the pyelitis developed as an additional factor? His headache and leg symptoms appeared at the same time. How long the pyelitis existed we do not know but that it had its influence upon the leg was proven by relief of the latter following pelvic lavage. It is not far fetched to surmise that the kidneys may have obtained their infection from the frontal sinus. Speculation as to the sequence of events, however, I leave to you.

That focal infection may produce the typical signs of inflammation in some part of the body quite remote from the focus is illustrated by the following case.

One of our Medical Students, 23 years of age, awaked one morning with pain over the right instep. The next day the foot began to swell, first over the instep, and then extended over the entire dorsum up to the ankle. Redness and heat promptly followed, limited, however, to an area about 3 inches in diameter over the instep. The pain was quite severe during the first few days but lessened to a dull steady ache. His temperature ranged from 99.2 to 102.2 degrees. He had local treatment, ichthyol, hot compresses, and hot continuous bath without improvement. I saw him 5 days after onset and elicited the additional history of an acute "sore throat" antedating the foot trouble by several days. This had persisted but was less severe. He still had pain in his throat, however, and he had difficulty in swallowing. Examination showed that both tonsils were hypertrophied and injected, the right more than the left. The right foot was quite swollen over the entire dorsum to the sole and from the phalangeal joints to 2 inches above the ankle. The instep was quite red, hot, and exquisitely tender upon palpation. He was sent to the University Hospital where X-ray showed no evidence of bony change or arthritis. He was advised to have his tonsils removed, but the throat specialist felt that the infection was too acute for operation at that time. His throat was treated by local applications and gargles and the foot kept in

[1] Read before The Southern Surgical Association, White Sulphur Springs, West Virginia, December 11, 12, 13, 1923.

continuous hot bath. The former improved but the latter did not. Ten days after admission his tonsils were removed by Dr. J. M. Hull. Within 24 hours the pain had disappeared from his foot, the redness, heat, and swelling promptly followed, so that within 3 days there was no evidence of the former foot trouble. He was discharged several days later fully recovered. Surely a local infection could not have cleared up so rapidly and it must therefore have been a toxic manifestation—toxic from focus of infection elsewhere in the body.

I wish to mention another type of case, presenting something of a combination of the above two.

A young white man, muscular and well developed, gave a history of recurring attacks of swelling ot both lower extremities with mottled areas of redness and pain. Repeated searches for cause, including filaria, had been made but without success. In February of this year (1923) he had had a Kondoleon operation for elephantiasis of both legs. He remained in the hospital about 6 weeks. He came to our city in June to accept a position and soon after arrival his legs again began to swell, pain, and ache, and irregular areas of redness, heat, and tenderness appeared. He was put to bed and ichthyol dressing applied over both legs. There followed some relief from the discomfort, but the swelling and areas of heat and redness persisted. August 8, 1923, I saw him in consultation with Dr. S. Lichtenstein. Both legs were swollen, the left more than the right, and scattered here and there over the entire leg were irregular areas several inches in diameter, red, hot and tender to the touch, erisipeloid in type. They were not progressive nor clearing up in the center as in true erisipelas but remained about the same after their first appearance. General examination was negative except for mild pyorrhœa of the lower front teeth and imbedded, adherent, injected tonsils. I referred him to Dr. W. E. Clark for dental treatment and to Dr. C. I. Bryans for removal of tonsils. Both were promptly attended to, his recovery was prompt and complete, and to date he has had no evidence of return of trouble.

These several cases have been selected to illustrate rather unusual manifestations of focal infection.

Lymphadenitis, of course, always calls for a search for the source of infection and we have been in the habit of looking only, or most diligently at any rate, distalward for the focus. In these, such a search was fruitless and we were forced to look elsewhere. Focal infections around the head are quire commonly associated with cervical adenitis but that they might produce a toxic lymphadenitis of a single extremity or cellulitis, with all the cardinal signs of acute inflammation, was rather a revelation to me.

CONCLUSION

I would urge a close physical examination and the careful weighing of facts obtained, before employing radical treatment in such cases of obscure local manifestation, whether cellulitis or lymphangitis. To have opened the foot in Case 2, would certainly have been a needless procedure, to say the least, and it is extremely doubtful if even any temporary benefit would have resulted, had the error been made. In Case 1, as in Case 3, recurrence would most probably have followed had a Kondoleon been done; such an operation was quite seriously considered before the benefit from pelvic lavage had been obtained. This, of course, afforded us the first definite clue as to the etiology; and suggested focal infection to us.

ADENOMYOMA OF THE RECTOVAGINAL SEPTUM; ASSOCIATION WITH PREGNANCY; RADIUM TREATMENT; APPARENT RECURRENCE

Adenomyoma of the Uterus; Relation to Malignancy

By LOUIS HERLY, M.D., New York

In 1895 von Recklinghausen[1] called the attention of the medical world to the subject of adenomyoma of the uterus and fallopian tubes and again in 1896 to adenomyoma and cystadenomyoma of the uterus and tubal walls.

Thomas S. Cullen,[2] however, had formulated his views, which he still holds, 2 years before von Recklinghausen's work appeared. He was the first to emphasize the origin of adenomyomata from the mucous membrane of the uterus.

Ludwig Pick acknowledged the accuracy of Cullen's findings, but would not allow that his conclusions were comprehensive enough to explain *all* adenomyomata.

Cuthbert Lockyer agrees with Pick, as no one etiological theory can possibly be made to explain all adenomyomata.

Adenomyoma of the uterus. The female pelvic organs form the site of election of these tumors (Fig. 1), but they have also been found in the bowel and stomach. Von Recklinghausen divided adenomyomata into two classes: (1) Those situated at the periphery of the uterus and in the tube; and (2) those arising centrally. The former, he believed, arose from a numerical increase of the wolffian tubules, and the latter he considered rare and that they were prone to undergo cancerous changes, since he had seen three cases in which this malignant change had occurred.

Histologically, he regarded these masses as "organoid tumors" in which the whole structure of a glandular apparatus could be traced (Fig. 5). In addition to the gland elements, another typical feature was the "cytogenous connective tissue" which covered the canals and in which they lay embedded. Around the larger cysts, this tissue was scant, the epithelium lying directly on the muscle. Rounded elevations within some of the cystic spaces were regarded as pseudoglomeruli, and to them was attributed the function of secretion and of allowing diapedesis of red blood corpuscles, which latter were found, together with yellow and brown pigment and hyaline bodies, in the stroma surrounding the cysts.

The foundation upon which von Recklinghausen's wolffian theory rests is the fact that early in fetal life the wolffian and muellerian ducts cross each other at the "tubal angle," i.e., at the isthmic portion of the fallopian tube or cornu uteri. It is assumed that the epithelium of the two ducts comes into such close contact that a confluence of these tissues may conceivably take place. This provides opportunity for wolffian rests being found in the interstitial part of the fallopian tube and in the cornu of the uterus. Thus, one of the features of von Recklinghausen's adenomyoma was its localization. Its other characteristic was the peculiar morphology which consisted of what was thought to be an exact reproduction in a cornual adenomyoma of the component parts of the mesonephros.

Chiari, Martin, and Schauta supported the theory of histoid changes consequent on inflammation.

Schroeder, Ruge, Schottlander, Orloff, etc., were in the field with the muellerian theory of origin.

Both embryonic theories, muellerian and wolffian, may hold good for a limited number of cases. For the majority of cases of uterine adenomata, however, the congential theories have had to give place to the "acquired mucosal" or "diverticular" theory of Cullen.

The latter seems to have been content with proving the *acquired* or mucosal nature of the diverticula, thus disproving the *congenital* theory.

[1] Von Recklinghausen. Wien. klin. Wchnschr., 1895; cited by Hirschwald, Berlin, 1896.

[2] Cullen, Thomas S. Cited in Eden and Lockyer's New System of Gynecology, 1917, ii, 311.

Von Franqué carried the solution of the problem of the etiology of adenomyomata a step further than Cullen; for after satisfying himself that mucosal diverticula resulted in glandular proliferation he raised the question: "Why does the mucosa infiltrate?" This he answered by demonstrating that the epithelial infiltration was a phenomenon found in connection with partly healed salpingitis, and particularly so in tuberculous cases.

This view as to an inflammatory factor was utilized by Legueu and Marien who attributed the adenomyomatous condition of the uterine wall to a preceding chronic inflammation of the endometrium.

The mucous membrane origin received increasing support (Lockstaedt, Baldy and Longscope, Robert Meyer) and so supplanted the fetal-relic theory. In 1900 Gottschalk, Opitz; and in 1901 E. Kehrer worked on the same lines with similar results. Lubarsch in 1902, and Robert Meyer in 1903 found that the etiology of the specific inflammation was of no importance, mucosal invasion occurring in every type of inflamed tube.

The cause of the infiltrative activity on the part of the epithelium is a pre-existing inflammation. Granulation tissue, areas of round-cell infiltration, and proliferating connective tissue are all permeable to benign, invading epithelium. This is a healing process, the sequence being (a) injury; (b) regeneration; (c) epithelial heterotopy. When the invading epithelium penetrates muscular planes, the result is an adenomyoma. When fibrous tissue is involved, the resultant is a fibro-adenoma. As adenomyomata afford us the best example of benign epithelial invasion or heterotopy, and as this epithelial heterotopy is essentially an inflammatory phenomenon, it points to the conclusion that adenomyomata themselves are examples of an inflammatory product. Nature intended the invading epithelium to aid in the repair of the damage done by inflammation. In adenomyoma we seem to see this process of repair overreaching itself.

Robert Meyer also partly accepted the serosal theory advanced by Iwanoff, which assumes a metaplasia of the endothelial cells of the peritoneum; to such a degree as to become cubical or even columnar. Some think it occurs with pregnancy; others describe it as a regenerative process. Robert Meyer thinks that under the influence of inflammation the peritoneal epithelium proliferates and sends down buds of cells into the subjacent tissues. The buds then proliferate and form branching tubular adenomatous structures. These latter are lined by columnar epithelium and the crypts are indistinguishable from those derived from an invasion by true mucous membrane. Furthermore, the connective tissue adjacent to the adenomatous structures changes its character as the result of inflammation, and becomes the cytogenous tissue which is one of the predominating features of adenomyomatous growths, and this cytogenous tissue, even in serosal adenomyomata, takes on decidual reaction in response to the influence of pregnancy.

During a recent interview of the writer with Robert Meyer, on this subject, he stated that the wolffian body could not possibly be a source for the development of adenomyomata since the morphological picture of the latter has no resemblance whatever to this embryonal organ, or any of its developmental products. Neither does this organ at any time come into contact with locations where adenomyoma is found in adult life. He does believe that all adenomyomata arise in an inflammatory basis and are either inclusions or proliferations into the depth from either uterine mucous membrane or from peritoneal serosa. Only an origin from peritoneal serosa will explain the presence of adenomyomata in the pouch of Douglas. He believes that the adenomyomata are not malignant for they do not recur nor do they metastasize.

Cullen describes the cases he has observed as consisting of uterine mucosa within myomatous tissue. These cases always originate from mucosa lining the uterine cavity. To establish the mucosal origin it is not necessary that uterine glands be traced by continuity. For this gland tissue is surrounded by a stroma identical with that surrounding the uterine glands in their normal location and in some cases miniature uterine cavities are scattered throughout the myoma (Fig. 11). Furthermore, this gland tissue retains its

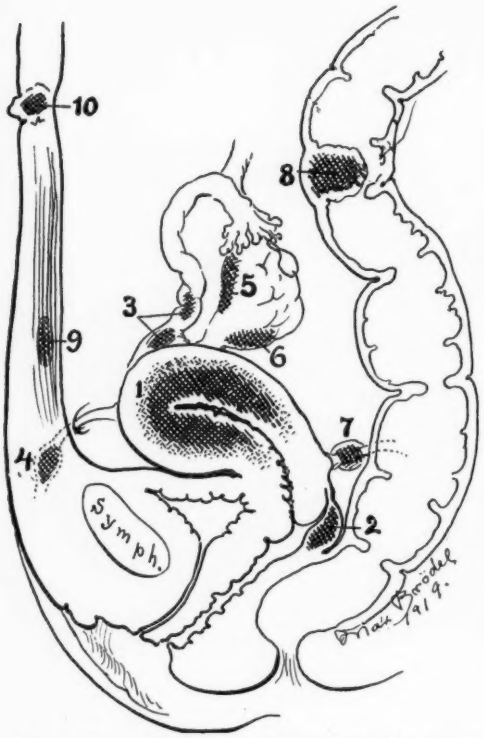

Fig. 1. Ten localizations of adenomyomata in the order of their frequency. (T. S. Cullen, Arch. Surg., 1920, i, 215.)

function, even if misplaced, for the gland lumen fills with blood, and in pregnancy the stroma undergoes decidual reaction.

According to Lockyer the simplest classification is to divide these tumors into uterine and extra-uterine. The uterine may be subdivided, according to clinical observation, into central and peripheral. The central are mucosal in origin. The genesis of the peripheral is debatable.

ADENOMYOMA OF THE RECTOGENITAL SPACE

Cullen[1] classifies the adenomyomata in this location as follows:

1. Small adenomyoma lying relatively free in the rectovaginal septum.

2. Adenomyoma adherent to the posterior surface of the cervix and at the same time to the anterior surface of the rectum.

[1]Cullen. Bull. Johns Hopkins Hosp., 1917, xxviii, 343.

3. Adenomyoma gluing the cervix and rectum together and spreading out into one or both broad ligaments.

4. Adenomyoma involving the posterior surface of the cervix, the rectum, and broad ligaments, and forming a dense pelvic mass that cannot be liberated.

In Cullen's experience all these tumors, no matter where situated, show the same clinical reaction; namely, swelling up at the menstrual period.

When the growth arises in the cervix and proliferates posteriorly, it will spread into the rectovaginal septum and become attached to the rectum, and the latter becomes fixed to the cervix.

These growths, of course, are found only in women. The importance of the differentiation between carcinoma of the bowel and adenomyoma of the rectovaginal septum is obvious.

If the uterus is myomatous it makes it probable that the suspected pelvic mass is an adenomyoma. If the growth is apparently muscular in origin the diagnosis is still more probable; and if the growth is cystic the diagnosis of adenomyoma is practically certain.

If the entire growth is removed no further trouble need be feared. If portions be left these will continue to grow and will lead to more pelvic adhesions and finally produce complications that may result in death or permanent invalidism.

Histological picture. The growth consists of non-striped muscle and fibrous tissue. Scattered throughout this are typical uterine glands. The latter may occur singly and in direct contact with the muscle or may occur in groups. Usually they are separated from their surroundings by the characteristic cytogenous stroma of the uterine mucosa. One may see islands of this stroma without the presence of glands.

Symptoms. Profuse menstruation is the most prominent symptom observed. It may be either painless or accompanied with colic-like pain. Rectal pain is observed in some cases. When the growth has advanced so far as to invade the broad ligament pain is experienced in this region due to two factors: (1) pressure on the local nerves; and (2)

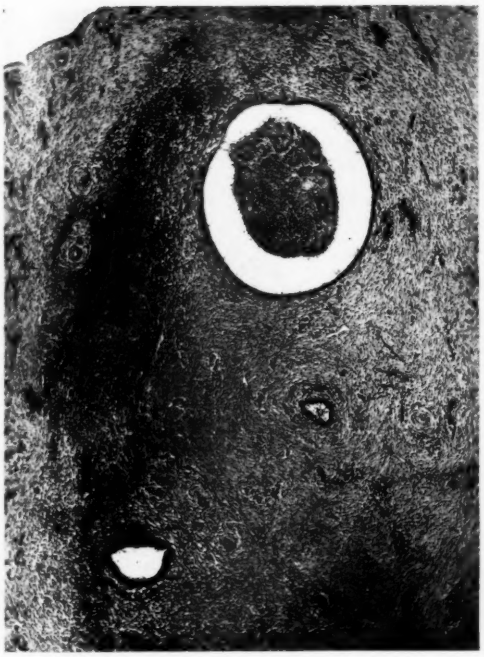

Fig. 2. Adenomyoma of the rectovaginal septum. Cystic spaces lined with cubical or cylindrical epithelium, surrounded by lymphoid tissue and embedded in a fibromuscular stroma.

Fig. 3. Adenomyoma of the rectovaginal septum. Typical uterine glands embedded in a stroma of fibrous and non-striped muscle tissue. Rounded elevations were within some of the cystic spaces.

swelling of the neoplasm at the menstrual period.

Physical examination. In the majority of cases the growth appears as small nodules situated behind the cervix and just above the posterior vaginal fornix. They are painful to touch, and especially during intercourse. They are therefore detected early while they are small. Later the growth spreads, involving the rectum and the adjoining cellular tissues of the broad ligament, especially on the left side. The physical signs then resemble those of a posterior parametritis. The mucous membrane of the posterior vaginal wall becomes puckered and when the mass breaks through it a bright red, hæmorrhagic, papillomatous small nodule is seen in the posterior vaginal fornix.

The rectal mucous membrane is never invaded, this being limited to the muscle and submucosa. Still they have frequently been mistaken for rectal carcinoma and treated as such.

Some are discovered because of local pain experienced, others accidentally during operations for various pelvic conditions.

At the present time, many, including Lockyer, do not regard adenomyomata of the rectovaginal septum as true neoplasms, but rather as inflammatory products. Whenever the mass is accessible a portion should be removed for microscopic examination.

On *vaginal examination* one can detect a definite thickening. This may be situated in the posterior wall to the right or left of the cervix, but is usually directly behind it. It may vary from 1 to 3 or 4 centimeters in breadth. The thickening is occasionally nodular. As a rule, however, it is diffuse, hard, and reminds one of dense inflammatory tissue or of a small adherent myoma. In some cases the nodule moves with the movement of the

Fig. 5. Genesis of "pseudoglomeruli." Four sections from the periphery of an adenomyomatous module drawn by Ludwig Pick to demonstrate the "organoid" morphology these growths were supposed to possess. (From Pick, Arch. f. Gynaek., 1897, liv, 117.)

cervix; in other cases the nodule seems firmly fixed to the rectum.

On *rectal examination* these tumors, if situated directly behind the cervix, can often be more clearly felt than through the vagina. If the growth be adherent to the rectum, the

Fig. 4. Adenomyoma of the rectovaginal septum. Higher power view of one of the cystic spaces, illustrating one stage in the formation of the "pseudoglomeruli." (See Figures 5, a, b, c and d.)

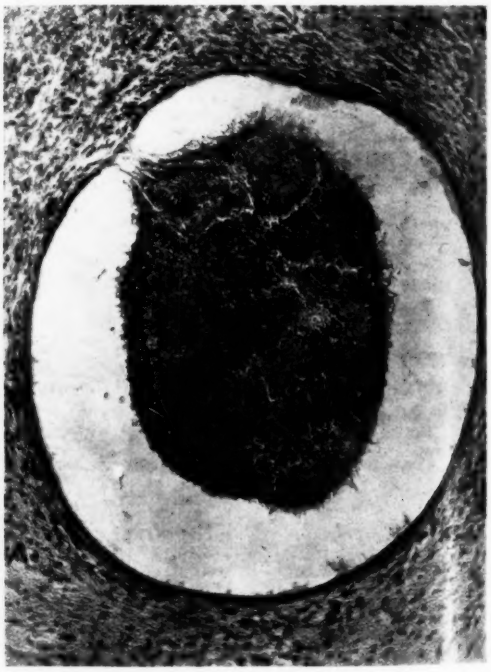

Fig. 6. Adenomyoma of the rectovaginal septum. Higher power view of cystic space with "pseudoglomerulus" (Fig. 2) illustrating clearly the genesis of the pseudoglomerulus.

Fig. 7. Adenomyoma of uterus associated with malignancy. Uterine polyp showing at external cervical os and removed with curette.

Fig. 9. Adenomyoma of uterus associated with malignancy. Cancerous nodule showing at external cervical os and removed with curette.

bowel over this area is hard and does not yield. The rectal mucosa, however, even over the growth, is, as a rule, perfectly normal, although the tumor mass projects slightly into the lumen of the bowel.

Diagnosis. Adherent adenomyoma of the rectovaginal space has been mistaken for hæmatocele, for pelvic abscess, for cancer of the rectum, and for ahderent adnexa in the pouch of Douglas. Sometimes the mass ulcerates through the vaginal mucous membrane bleeding on touch and causing a red or brownish vaginal discharge.

Prognosis. Freund considers the prognosis in adenomyoma poorer than in myoma. Curetting and medical treatment make it worse.

Fritz Volk points out the danger in curetting, for it may lead to hæmorrhage, which may, and did in a case reported, lead to a fatal result.

Lockyer summarizes the outlook by regarding an adenomyoma as a hæmorrhagic and painful structure which is found associated with inflamed adnexa, pelvic peritonitis, parametritis, infiltrations into the bowel, caseating tubercle, carcinoma and sarcoma.

Treatment. For extensive growths of the rectovaginal space partial or total resection of

Fig. 8. Adenomyoma of uterus associated with malignancy. Adenomyomatous nodule showing at external os and removed with curette.

Fig. 10. Adenomyoma of uterus associated with malignancy. Cancerous nodule (Fig. 9) showing irregular gland structure. Genesis of carcinoma from adenomyoma or abortive attempt of cancer to form gland structure?

the bowel is not necessary. When the diagnosis has been established histologically, showing it not to be a carcinoma but an innocent epithelial infiltration, many advocate a complete hysterectomy removing as much of the growth at the same time as possible without resecting any part of the rectum.

Lockyer states that all forms of radiotherapy are generally disappointing. He says that they may be expected to excite the inflammatory process which is the pathological basis of the disease. Griffith reported a shrinkage of the mass by the use of the X-rays.

A case here reported, which, beside demonstrating the effect of radium, also illustrates the effect produced by an associated pregnancy.

This refers to a young woman, 30 years of age, who 6 years before had been delivered of a child with high forceps, made necessary by a contracted pelvis. A considerable laceration resulted, which was immediately repaired. The recovery was uncomplicated except for a small breast abscess. One year later she aborted at the tenth week of pregnancy.

The patient had never had a serious illness, suffered any accident, nor been subjected to any operation.

Her family history but for a strain of nervous and mental disease was of no consequence.

The present illness was first noted 2 years ago (in 1916), when the patient had pain during coitus for a few months and, on one occasion, noticed bright-red blood flowing from the vagina following an intercourse. This was soon followed by a brownish vaginal discharge with a bright blood admixture observed between menstrual periods. Though the amount was slight it was observed daily. A gynecological surgeon, then consulted, spoke of feeling a nodule in the posterior vaginal wall, but advised the patient it was of no importance and treated the bleeding with tamponage. As a result of this treatment, the bleeding became less but the brownish discharge continued.

Soon the patient felt pain on exertion (lifting the baby, ironing, etc.) and especially on defæcation. This latter pain she described as being very severe. Medical consultation attributed this symptom to hæmorrhoids. However, the pain now became continous, the patient being unable to find any position, sitting or lying down, in which she was comfortable, being most uncomfortable when walking. (At that period patient was compelled to have her husband commited to an asylum with a diagnosis of paresis and a positive 4+ Wassermann). She came to me for information as to whether her vaginal condition was in any way related to her husband's syphilis. Two Wassermann examinations, at an interval of 3 months, both proved negative.

On *examination* a small nodule was felt in the posterior vaginal wall, behind and to the right of the cervix. This little mass was about 1 centimeter in diameter, presented an irregular surface to the examining finger, was very tender, and bled easily. Rectal examination was even more painful and disclosed that the rectal musoca was not involved, being freely movable over the small mass.

When *examined through a vaginal speculum* the nodule was disclosed to consist of a series of papillomatous excrescenses perforating the vaginal mucosa and appearing above its surface for about one-half a centimeter. Their color was a blood-red and they bled when touched with a cotton-wrapped probe.

All pelvic organs were in their normal positions, not enlarged, tender or presenting any pathological signs.

During my absence from the city, another surgeon, at the Lying-in Hospital of New York, made an attempt to remove this mass. He found that since my last examination a smaller mass had also broken through the vaginal mucosa, presenting similar characteristics to the one first seen, and appearing in the posterior vaginal wall to the left of

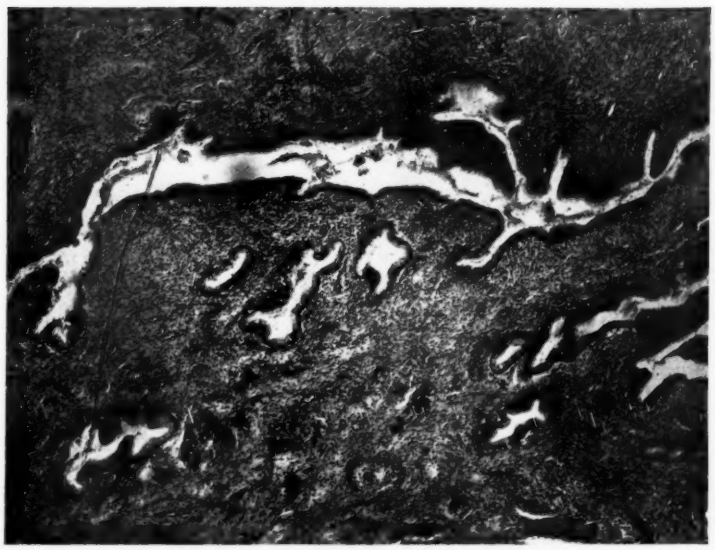

Fig. 11. Adenomyoma of uterus associated with malignancy. Adenomyomatous nodule found in cervix following the hysterectomy for carcinoma. Note the large glandular structure, almost a reproduction of a uterine cavity as described by Cullen.

the cervix. Apparently these nodules were separate and distinct from each other, being separated by about 2 centimeters of normal vaginal wall.

He also reported to me that he had made an attempt at removing these masses, employing general anæsthesia. He excised from the right side a strip 2.5 centimeters long, 1 centimeter wide, and 1 centimeter deep. This strip bore the nodule of the right side. He also removed a strip 1.5 centimeters long and 0.75 centimeter wide and deep, bearing the nodule of the left side. However, he found that he had not succeeded in removing the entire mass because of its attachment to the rectum, nor could he control the bleeding by ligatures or sutures. The patient's vagina was tightly packed with gauze. The bleeding continued for 10 days in the hospital, gradually diminishing during the following 2 weeks at home. But the pain was constantly becoming worse. During the next 2 months the bleeding finally ceased but the pain was very severe.

The *histological examination* of the tissue removed disclosed cystic spaces lined with cylindrical epithelium (Figs. 2 and 3). They were surrounded by the lymphoid tissue, described by Cullen and others as being characteristic uterine stroma. These typical uterine glands were embedded in non-striped muscle and fibrous tissue. Islands of this cellular stroma without the presence of glands were seen (Fig. 2). The gland spaces contained red blood corpuscles in various stages of degeneration. Rounded elevations within some of the cystic spaces (Figs. 2, 3, 4), regarded as pseudoglomeruli, were also observed. The explanation for the formation of these as given by Ludwig Pick[1] impresses the writer as a reasonable one (Figs. 5a, b, c, d), though Pick attempted to explain a wolffian tubule origin to which the present writer does not subscribe. The genesis of the pseudoglomeruli is well illustrated by one of the specimens (Figs. 2 and 6).

Having failed to remove the growth completely by means of surgery our next recourse was to a physical agent and we selected radium as the means. In January, 1920, the patient was treated with a surface application of radium, the latter being held in position with dental modelling compound. The treatment was under the direct supervision of Dr. Harold C. Bailey and carried out by him at the Memorial Hospital, New York.

This treatment gave the patient no further relief and objectively the nodules remained unaffected.

In April, 1920, Dr. Bailey buried some bare tubes of radium emanation into the nodules. Following this the pain was diminished in intensity but not gone. The nodules could no longer be felt 1 month later.

In the fall of the same year the nodules recurred in the old locations. Bleeding and pain was associated with this recurrence.

The patient then became pregnant. (The first husband had meanwhile died of his paresis and the patient had married a healthy man.) Evidently small rests remaining after the bare-tube treatment had swelled as a result of the pregnancy and been

[1]Pick, Ludwig. Arch. f. Gynec., 1897, liv, 117.

the cause of the recurrence. Unfortunately we were not able to obtain a specimen for microscopic examination during the pregnancy. Fearing the further effect of the pregnancy and especially of the labor on these nodules the writer interrupted the pregnancy at the third month.

More bare tubes were buried into the growths and they, as well as the symptoms, promptly disappeared.

Another pregnancy soon followed and the patient was very anxious for issue from the new union. (Evidently the radium treatments had not deleteriously affected the ovaries.) Again the pregnancy exhibited the characteristic subjective and objective effects in the regions of the original growths. The writer, also taking into consideration the pelvic contraction, necessitating a high forceps operation in the previous labor, decided to allow the pregnancy to go to term and then deliver the patient by a cæsarean section. This was successfully accomplished. Following the cæsarean operation and to the present date, now 3 years, the patient has not had any symptoms from the adenomyoma nor have any palpable nodules appeared. To the eye the previous localizations are now only apparent by a telangiectasis similar to that which appears in the skin following heavy doses of X-ray.

It is interesting to note that other observers had reported that during pregnancy, in many cases, the cellular stroma around the gland tissue of the adenomyoma takes on decidual changes.

Cullen reports a case in which there was an unruptured tubal pregnancy on the right side. There was a myoma in the fundus and an adenomyoma of the left uterine horn. The stroma of the latter had undergone a decidual reaction although the adenomyoma was at least 9 centimeters away from the tubal pregnancy. W. S. A. Griffith showed microscopic sections of portions of tissue from an adenomyoma of the rectovaginal septum, in a woman who was near full term. The cellular stroma was seen to have undergone marked decidual changes.

This case suggested to the writer the possibility of another etiological factor, beside the inflammatory one, namely, the mechanical implantation of uterine glands into the vaginal laceration during the high forceps operation performed some years before the appearance of the adenomyomata. The laceration having been immediately repaired these glandular structures were, practically, inclusions, such as are known to occur in wounds of the skin and which also result in cystic growth.

Any information relative to similar experiences would be appreciated.[1]

Association with malignancy. The adenomyomata of the rectovaginal septum represents a type of neoplasm that is essentially benign yet infiltrates into the muscular layer. Adenomyoma may, however, become malignant though probably very rarely.

In Lockyer's opinion an adenomyomatous change may form a benign intermediate stage in the transition from an inflammatory to a malignant process. This is made probable by the observation of tubules lined with a single layer of cubical epithelium lying in the midst of cancerous areas in cases of adenocarcinoma of the fallopian tube.

Von Recklinghausen in one of his first monographs (1896) on this subject put on record three malignant cases associated with adenomyoma of the uterus.

Sitzenfrey, Rolly, Schuetze, Max Schwab, H. Dilman, and Gruenbaum have reported the occurrence of malignancy in association with adenomyoma.

Cullen has published six cases of epithelioma of the cervix associated with diffuse adenomyoma of the body of the uterus and two cases of diffuse adenomyoma occurring with adenocarcinoma of the body of the uterus.

Sarcoma associated with adenomyoma has been reported in two cases, those of Iwanoff and Bauereisen.

To these cases of malignancy associated with adenomyoma of the uterus, the writer wishes to add another.

This relates to a woman 48 years of age, who sought medical advice for pain in the sacral region. She had never during her sexual life had any pelvic trouble. Twenty years before she had been delivered of twins, her only pregnancy. At the time of consultation she had no bleeding, having been in menopause for several years. Careful questioning brought out no further symptoms or signs, her only complaint being backache.

On examination she was found to be a well nourished woman with healthy vital organs.

Vaginally one could see protruding from the external os of the cervix three or four small, rounded, bright-red nodules, each about 2 or 3 millimeters in diameter. They were not tender to touch nor did

[1]Recently, the writer has seen another case of adenomyoma of the rectovaginal septum following a forceps operation with resulting severe tearing of the perineum and posterior vaginal wall.

they bleed easily during the manipulations. They seemed to be sessile and were taken off with a sharp curette. Further pelvic examination proved negative. The microscopic examination of these nodules revealed the following: One nodule was a conventional uterine polyp (Fig. 7). One showed the characteristic structure of adenomyoma, dilated uterine glands surrounded by a cytogenous tissue and embedded in a fibromuscular stroma (Fig. 8). One however, revealed an entirely different morphology, namely a typical medullary carcinoma (Fig. 9) with an irregular gland structure in one corner (Fig. 10).

These specimens were examined by James Ewing, Francis C. Wood, and William H. Woglom, who all agreed on their malignant nature.

Is this an abortive attempt of the cancer cells to build up glandular structures or are these glands similar to those seen in the section of the adenomyomata (Fig. 10) showing a transitional stage in the malignant process? On this microscopic evidence the writer performed a radical hysterectomy (extended Wertheim).

The specimen removed revealed a small uterus with two small intramuscular fibromyomata (about 2 centimeters in diameter) near the cervical junction and to our surprise no further evidence of any malignant disease. On examination of a serial section further areas of adenomyoma were found in the cervix (Fig. 11).

The writer wishes to place this case on record as an intimate association of adenomyoma with microscopically malignant changes and also as one of the cases where the curette apparently removed the entire malignant process.

The patient, 3 years after the operation, is in perfect health and a recent examination reveals nothing of a pathological nature.

EPIDERMAL CANALS INFECTED WITH GONOCOCCI

A Description of Three Cases

By ERNEST RUPEL, M.D., Indianapolis, Indiana

ABNORMALITIES of embryologic origin in the raphé of the penis are not common and there is scarce mention of the subject in the American literature. Kocher (6), back in 1887, described cysts of the raphé of the penis and scrotum, and, of the earlier writers, Thoele (10), in a review of the literature, made an outstanding contribution. Rather recently, Gutmann (4) reported his study of three instances of cysts and one subcutaneous tract. Milian (8), with others (1), has reported the finding of epidermal canals in the raphé. The canal described by Milian extended the full length of the penis, but those described by the others were shorter.

A description of three cases of epidermal canaliculi infected with the gonococcus may be instructive.

Case 1. Age 23. First gonorrhœal infection 3 years previous and had had many recurrences. He gave a history of having suffered a contusion of the penis while riding a horse 3 years before, since which time there had persisted a small opening just back of the frenum. Though no trouble had been experienced from the opening, it had always discharged a watery secretion.

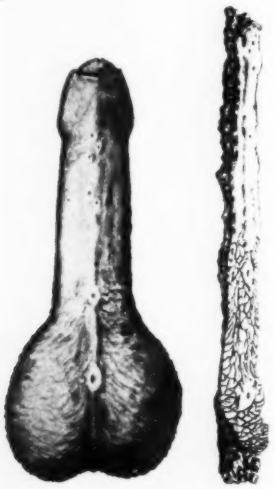

Fig. 1 (left). Sketch of penis and scrotum showing ventral raphé with underlying cord in the course of which the suppurating nodules were situated.

Fig. 2. Sketch of the specimen, about three-eighths of its natural size.

The foreskin was short. From a small orifice 1 centimeter back of the frenum, a cord-like subcutaneous thickening passed anteroposteriorly and terminated in a blind sac 3 centimeters from the front. No connection with the urethra could be made out; no pus found.

The next day pus with intracellular diplococci exuded from the tract.

After 3 days the patient disappeared. With a severe urethritis he returned at the end of 11 months, and at this time the tract was open at both ends and discharged gonococci. Silver nitrate solution passed freely through the channel.

Again he disappeared for a year, at the end of which time the urethritis had subsided but the canal still discharged gonorrhœal pus.

The tract was excised and the wound healed promptly.

Case 2. Age 23. For 2 years multiple fistulæ (Fig. 1) in the raphé had been discharging gonorrhœal pus. These fistulæ were the persistent remains of pustular eruption which formed in the raphé immediately following a peri-urethral abscess, a complication of his only attack of gonorrhœa. The infected follicle had been located mid-shaft and the pustules seemed to spread gradually, both anteriorly and posteriorly. The inflammation incident to the formation of one of the recent openings had caused him to seek medical aid, and various antiseptics had been injected into the openings but the infection persisted.

A fibrous cord could be felt in the raphé, extending from a point 1 centimeter back of the tip of the unretracted foreskin to a point on the posterior surface of the scrotum a little below the middle. There was no connection of the cord with the urethra but the multiple fistulæ were intimately associated with the tract, for solutions injected into any one of the openings would flow from out the others. The one farthest back had a considerable area of inflammation around it, and, in regard for this, mixed vaccine was given for 15 days before excising the tract. Excision resulted in prompt healing and no subsequent trouble. He had no active or inactive urethritis at the time of operation.

Case 3. (July, 1923.) Age 27. This patient had been cured—so far as could be determined—of gonorrhœa 3 years before. His record shows that examination of the external genitalia disclosed nothing abnormal at that time. He had no recur-

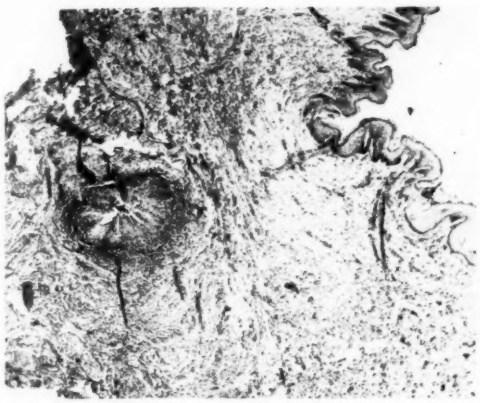

Fig. 3. Low power photomicrograph of tube in its most narrow region.

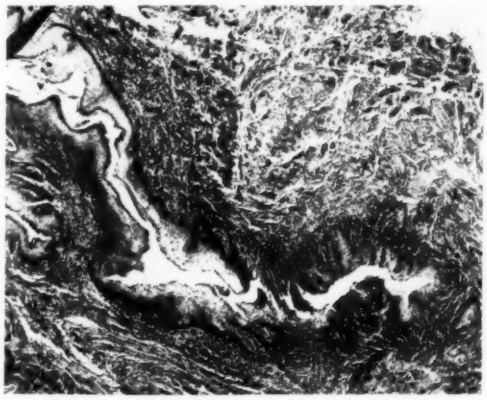

Fig. 4. Low power photomicrograph of tube through one of the fistulous openings.

rences of the urethritis. Several "sores" on the ventral surface of the penis had caused him to return to my office. These lesions had all appeared in the space of the last 24 hours. They were very tender to touch, had an area of inflammation about each one, were all in the raphé, and were scattered from within 2 centimeters of the coronal sulcus to the perineoscrotal junction. They were seven in number. A subcutaneous tract led from the front to the back and here again solutions passed freely through the canal and fistulæ.

The condition has improved spontaneously and with only two or three fistulæ showing activity he delays operative interference.

The most interesting feature is that his trouble came on absolutely independently of any urethral infection.

Unfortunately the specimen resected first was misplaced. From the second specimen (Fig. 2), fifty serial sections were studied. The pathological report follows:

Pathological Report by E. V. Hahn (Lab. No. 2759). The specimen consists of a narrow strip of tissue 18 centimeters long which can be divided into three portions. The middle 5 centimeters is narrower than the rest and has no integument. One distal portion (penile) is covered on one side by delicate wrinkled skin. This skin surface bears three small nodular elevations in the centers of which there are crateriform depressions. The other distal portion, 8 centimeters long, also bears skin which is of coarser texture. Two nodules similar to the ones above described appear in the midline of this portion. Between the nodules there is a subcutaneous cord-like elevation. Throughout the entire specimen, there is a dense fibrous column of tissue in which no lumen can be demonstrated grossly. This column of tissue is quite adherent to the skin and causes the subcutaneous cord-like elevation above mentioned. The section shows a thin line of folded skin, subjacent to which is a complete tubular structure seen in cross section. This tube is lined with irregular stratified squamous epithelium. The tube is completely surrounded by subcutaneous tissue containing strands of smooth muscle. In the vicinity of the tube, the elements of the fibromuscular tissue show a circular arrangement. The stratified epithelium of the tube varies greatly in thickness in the different sections studied. Its contour is very irregular, especially on the tissue side where it sends long processes into the connective tissue. In some sections small gland-like tubules lined with cuboidal epithelium are found lying near the tube. Serial sections show that the epithelium lining the tube is continuous with the squamous epithelium of the skin of the penis through the fistulous openings in the nodules mentioned in the gross description. In all sections, the tissue around the tube is densely infiltrated with lymphocytes and polymorphonuclear

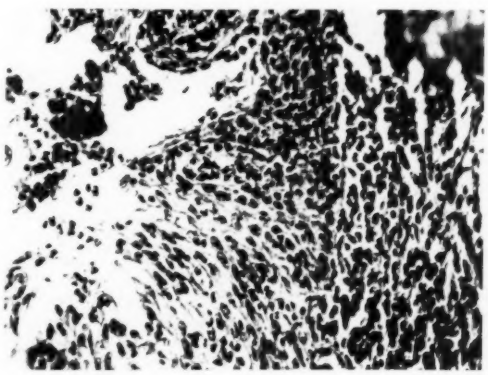

Fig. 5. High power photomicrograph showing stratified epithelium of tube and infiltration of subepithelial tissue.

leucocytes. Many polymorphonuclears are found in the epithelium and free in the lumen of the tube.

The openings of the third canaliculus show little inflammation now and the base, or floor, of the shallow depressions appears to be covered with normal skin tissue. The channel may be probed for a considerable distance in either direction. Beyond a doubt the epithelium lining the tract is of the ordinary squamous type.

The question arises as to how these tracts originated. The possibility of a lymph channel infection with subsequent ingrowing of skin was considered in the second case which had a history of progressive extension both posteriorly and anteriorly. Study of the microscopic sections (Figs. 3 and 4), however, does not support this supposition. That these canaliculi are broken off mucosal remains of the urethra is very improbable for the epithelium is not similar. One such accessory channel which was definitely the outgrowth or outbudding of the urethral canal has been described by Johnson (5) in a study of the male embryo. It is improbable that the tubes are para-urethral ducts for the latter have their origin in the urethra (2). Existence of these epidermal tracts has not been found in the embryo though the studies of the development of the urogenital organs has been very extensive as is indicated by the works of Pohlman (9) and Felix (3). Actual determination of the origin, therefore, is well nigh impossible.

The following quotation from Lewis (7) throws light on the subject. "The urogenital sinus acquires a cleft-like opening along the under surface of the penis. The elongated aperture closes from behind forward along the line permanently marked by a raphé." Very slight deviation from the normal process of closure could produce the malformations illustrated by these three cases. The tracts are most likely of embryologic origin.

Approximation of skin surfaces, though free from infection, does not cause fusion; and irrigation of the fistulous tracts does not obliterate them. They require, then, excision to effect a cure. Excision is simple and occasions little discomfort to the patient.

CONCLUSIONS

1. Epidermal canaliculi of the raphé of the penis are relatively uncommon, though commoner than the literature suggests.

2. Infection of the tracts is responsible for their discovery.

3. They are capable of harboring gonorrhœal infection many months—even years—and show little or no tendency toward spontaneous healing.

4. Radical excision is the method of choice in their removal.

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DEPARTMENT OF TECHNIQUE

EXCISION OF CERVIX FOR ENDOCERVICITIS

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IT is a well known fact that chronic endocervicitis is an infectious process involving the glands in the cervical mucous membrane, hence any form of treatment other than excision of these glands is only palliative.

The mucosa of the cervix, when it is the seat of chronic infection becomes swollen and everted, while the mucosa of the portio about the external os presents a circumscribed area of glandular proliferation. The columnar epithelium covering the mucosa of the cervical canal, under the constant stimulation of infection rapidly proliferates and pushes itself out on the vaginal aspect of the cervical rim, replacing the stratified epithelium which is normally present in this situation producing the so-called erosion. The continued congestion incident to such a condition produces a hypersecretion from the gland structure and a hypertrophy and hyperplasia of the cervical connective tissue. Sooner or later owing to the tissue hyperplasia, the crypts of the cervical glands become occluded and the secretion is retained, thus forming retention cysts, the so-called nabothian cysts, so commonly found in the region of the cervix. Section of a distended nabothian follicle shows a large, clear space which is lined with columnar epithelium and filled with mucus. Serial sections made from the excised cones of

Fig. 1.

Fig. 2.

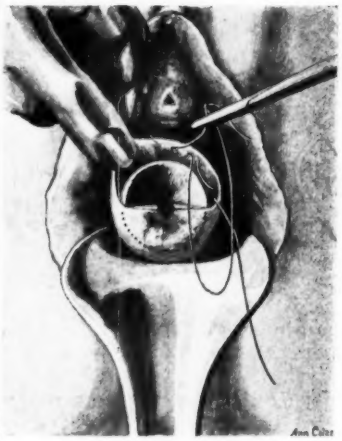

Fig. 3.

Fig. 1. A bilateral laceration of the cervix is made producing an anterior and posterior lip. Incision around canal through mucous membrane of portio vaginalis.

Fig. 2. The upper cone has been excised.

Fig. 3. A submucous half purse-string suture is made beginning at the angle.

Fig. 4.

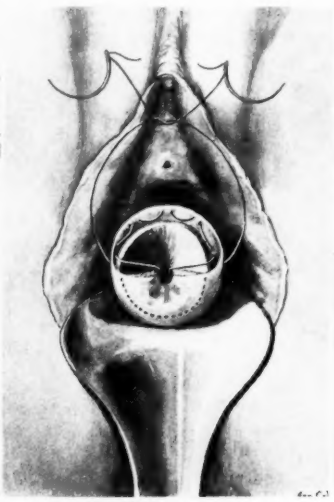

Fig. 5.

Fig. 6.

Fig. 7.

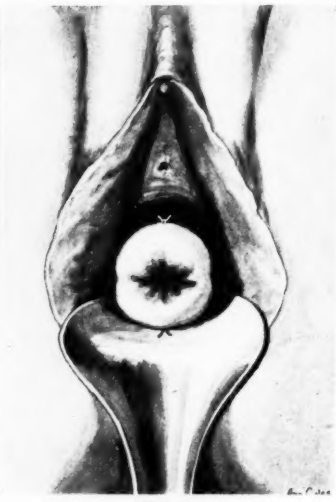

Fig. 8.

Fig. 4. When the opposite angle is reached, the needle enters the canal and comes through the flap.

Fig. 5. The suture is completed by bringing it through the opposite angle.

Fig. 6. The suture is made taut, the vaginal mucous membrane inverted, and the lower cone excised.

Fig. 7. The same suture is introduced in the lower lip.

Fig. 8. The suture is made taut and the operation completed.

cervical tissue similar to those shown in Figure 9 show erosions, chronic inflammation, cystic changes, etc., in varying intensity. Beginning at the distal end, we find marked inflammatory changes, but as we approach the proximal extremity, i.e., near the internal os, these changes are either barely perceptible or are entirely absent, showing the efficacy of the surgical procedure to be described under treatment below, in so far as the removal of the infected area is concerned.

Serial section at layer A (see diagram) made near the cervix shows marked inflammation and cystic changes, less so at layer B, and almost normal cervical tissue at layer C, which approaches the internal os.

Sturmdorf, in his very excellent work has called attention to the pathology resulting from chronic endocervicitis, and has suggested excision of the infected area. While we have found the Sturmdorf operation of great value, we, however,

offer this criticism. In the Sturmdorf operation, the cervical canal is excised as one cone, and the work is done blindly as one is unable to tell how far up the cervical canal the infection extends, and either too little or too much of the canal is excised and too much of the cervical musculature is sacrificed in excision of the cone. If too much cervical tissue is removed, the operation becomes a high amputation, which for obvious reasons should be avoided. Following the Sturmdorf operation, we have had cases of dystocia requiring cæsarean section. This was due to the fact that too much cervical musculature had been removed with the excised cone. If, on the other hand, not enough tissue is removed, infected glands are left behind and the purpose of the whole operation is defeated. For these reasons we have modified the operation and believe we have gained a distinct advantage. We have used the modified operation a number of times with excellent results.

PROCEDURE

With the patient anæsthetized and placed in the lithotomy position, the cervix is caught with a tenaculum and an incision made on each side beginning at the external os, producing a complete bilateral laceration and making anterior and posterior lips (Fig. 1). An incision is then made through the mucous membrane of the portio vaginalis of the upper lip encircling the limits of the eroded area. The mucous membrane of the portio is now pushed back for a distance of a centimeter or more if necessary, to secure a sufficient cuff of the mucous membrane completely to cover over the excised area of cervical tissue. Then, while traction is being made on the upper lip, the entire granular area surrounding the upper portion of the cervical canal is coned out with the scissors. All the infected portion of the canal can thus be excised by direct inspection, and there is no necessity for fearing that either too much or too little of the cervical canal will be removed. A suture of No. II chromic catgut on a full curved needle is placed through the previously liberated flap of vaginal mucous membrane. The suture begins at either angle and pulls up this flap in a submucous stitch, this to continue around (Fig. 3) until the opposite angle is reached. The angle stitch goes through the entire cervix beginning in the cervical canal and coming out through the flap of mucous membrane. A similar stitch through the other angle completes the upper suture (Figs. 4 and 5). When this suture is tied, the vaginal flap originally liberated is now inverted into the hollowed out shell of the upper lip of the cervix. This maneuver brings the cuff of vaginal mucosa into contact with the cervical mucosa (Fig. 6) and thus completely covers all the denuded areas, and furthermore, substitutes healthy vaginal mucosa as a lining for the infected cervical mucosa which has been removed. The cone of the lower lip is then excised in a similar manner, under direct vision (Fig. 6) and a suture similar to that described above is introduced (a semi-purse-string submucous stitch, Fig. 7). When this suture is drawn taut (Fig. 8) the operation is completed and a new canal created.

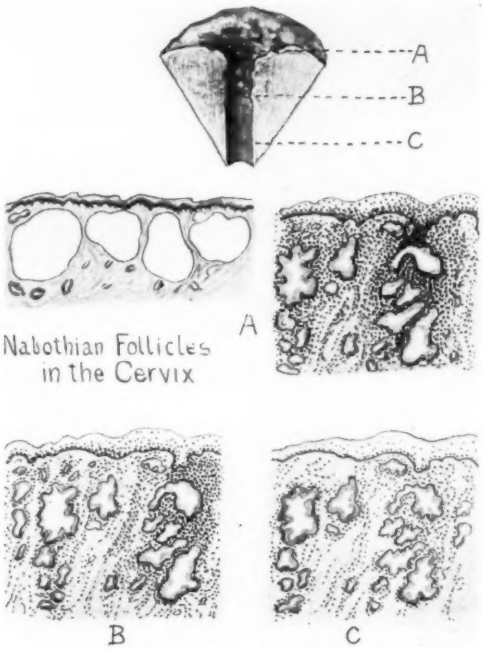

Fig. 9. Microscopic cross sections at different layers of excised cone, showing tissue changes greatest at external os and gradually diminishing as the internal os is reached.

CONCLUSIONS

We have done this operation a sufficient number of times to form some definite conclusions as to its value.

1. In the first place, it cures the leucorrhœa.
2. A tracheloplasty of this type does not interfere with normal dilatation during labor.
3. The relief of the focal infection cures the posterior parametritis in the uterosacral ligaments, and cures the lumbosacral backache which is such a prominent symptom in chronic endocervicitis.

FRACTURES OF THE SHAFT OF THE FEMUR

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IN spite of the vast experience surgeons have had with fractures of the femur, during the last ten years, both in civil practice and in army hospitals, the results are far from satisfactory in many cases. In a large measure, this is due to the inherent difficulties of this class of injury, which make it one of the most serious problems the surgeon has to face, and which place fractured femurs high in the ranks of permanently disabling injuries. Much work has been done to formulate some standard method of treatment which will improve the results, but the multiplicity of procedures now employed shows that little progress has been made. The two methods most in use are the gradual reduction by suspension and traction in connection with the Balkan frame, and immediate reduction and plaster cast. Both have their advantages and disadvantages. The traction method is the one used most extensively in the large industrial centers, because of its relative ease of application and because very few general surgeons are really adepts in the use of plaster of Paris. A poorly applied cast, or one composed of poor plaster, is worse than no treatment at all, for it does not hold the bones in position and covers up deformities which might otherwise be seen and corrected. When properly used, however, the cast is the most reliable method of fixation at our command. We base this statement on the results we have obtained by its use in the treatment of 153 cases of fractures of the shaft of the femur. From personal observation and from a careful study of the reported results in the literature, we do not see any reason to change our view. All of our cases are not perfect by any means, but we can assure you that the same thing is true, often to a much larger extent, with any other method used.

In normal, healthy bone, repair begins in from 2 to 4 days and is active at the end of 10 days. It is, of course, much more rapid in children than in adults. Fractures should be reduced as soon as possible as ill placed callus interferes with reduction; swelling is prevented and no callus is wasted. Callus once broken up never forms as rapidly again and repeated reductions and disturbances of callus is one of the most common causes of non-union. A plaster cast can be put on a fractured femur before it swells with perfect safety in 99 per cent of the cases, provided you know and watch for the danger signs in the other 1 per cent.

Fractures of the shaft of the femur are usually due to direct violence and occur during the period of greatest physical activity. They may occur at any part of the shaft, but the middle third is the most common site, about 60 per cent in this series, with 20 per cent each in the upper and lower third. The fractures are usually transverse or spiral. Green stick fractures are rare, even in young children.

The deformity usually seen is for the shorter upper fragment to be displaced forward and slightly abducted. This is due to the pull of the psoas, iliacus, pectineus, and abductors of the thigh, which have their insertion on the upper third, around the trochanters. This is important to remember in reducing such fractures, for the distal fragment, over which you have control, must be brought into line with the short proximal fragment, over which you have very little control. Interposition of muscles or fascial bands between the fragments, is a very rare cause for failure of reduction or non-union. Kidner reports 6 cases proved by operative reduction in a series of 77 fractures. This is an unusually high percentage but all of these cases were treated by the gradual traction method, which favors the healing of soft parts across the site of the fracture.

One of the greatest objections to the plaster cast is that the knee and ankle joints are necessarily immobilized for a long period of time. We know from experience that this causes atrophy of the articular cartilages and contractures of the soft parts about the joints, resulting in a certain amount of stiffness in all cases. In children this clears up in a few days, but in adults it may cause a permanent limitation of motion in the joint. About 5 per cent of our cases had some permanent loss of motion, in a few of which it was sufficient to seriously impair the joint.

CAUSES OF NON-UNION

The most common cause for non-union, in simple fractures, is lack of reduction. If the ends of the shaft are placed reasonably close together union is almost certain to follow. Repeated attempts at reduction with the consequent disturbance of callus is malposition's partner in crime. A few cases may be due to systemic disease or muscle interposition. Compound fractures with infection are frequently followed by non-union, particularly where there is loss of bone.

Fig. 1, A. Anteroposterior and lateral views of fracture of upper third of femur in a child.

Fig. 1, B. Anteroposterior and lateral views of same patient as in *A* showing good reduction, with end-to-end apposition, and solid bony union.

METHOD OF REDUCTION

An orthopedic table, with the usual attachments for extension and counter traction, is an absolute essential. Combined with this should be an X-ray equipment, which allows frequent fluoroscopic or plate control while the fracture is being reduced and before the cast is applied, thus assuring an exact knowledge of the position of the fragments at all times. The patient is given a general anæsthetic, usually ether, and when the muscles have become thoroughly relaxed the manipulation is begun. The unaffected limb is fixed to the foot piece under moderate traction. The affected thigh is then flexed to about 45 degrees and slightly abducted, as this is the normal position for the upper fragment to assume because of the pull of its muscular attachments. As we have very little control of this fragment, particularly when it is short, the lower fragment must be maneuvered up to meet it. The fragments are next angulated under slight traction until the ends of the bone impinge and can be locked, after which the thigh is gradually straightened until the normal anteroposterior, and lateral alignment is obtained. If the fragments slip by one another the maneuver is repeated. The position is now checked with the X-ray and the limb fixed in this position by traction on the foot and counter traction under the knee and at any other place that is necessary. A plaster cast is applied, extending from the upper chest to the toes on the affected side and extending to the knee on the unaffected side. The cast is removed at the end of 2 weeks in children, and 3 weeks in adults, the alignment of the leg carefully inspected, the position of the fragments checked by X-ray and the joints gently manipulated. Any angulation can easily be corrected while the callus is yet soft, and the position of the joints can be changed, thus preventing future stiffness. Careful observance of this simple precaution will often save much embarrassment in the future after solid union has taken place. A second spica cast is now applied, usually only taking in the injured limb, if there is satisfactory union and good position.

No set rule of thumb can be applied to all cases, each one being a problem unto itself in obtaining and holding the correct reduction. Much depends upon the shape of the ends of the fragments. Oblique fractures and transverse fractures, with several sharp points and notches, are reasonably easy to hold in position if you get a good end-to-end approximation. The most difficult fracture to hold is a short, smooth, slanting break which is almost impossible to lock at time of reduction, and which is very liable to slip by during the first week after the cast has been applied. We must often be satisfied, in this type, with ½ to 1 inch

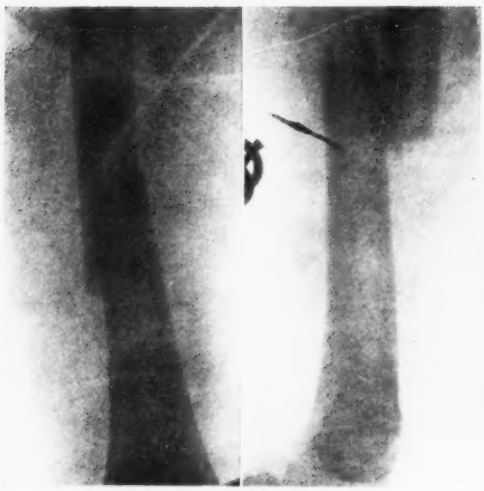

Fig. 2, A. Fracture of middle third of femur in a child. Anteroposterior and lateral views.

Fig. 2, B. Anteroposterior and lateral views showing position 4 weeks after injury. End-to-end apposition, good callus formation. Angulation easily corrected without danger of displacing fragments.

overlap and shortening, provided the anteroposterior alignment is good. The question to answer is whether it is not better for the patient to have a straight leg one inch short than to subject him to the danger and uncertainty of an open reduction. Open reduction, regardless of the type of internal fixation used, does not give 100 per cent cures by any means. An inch shortening may easily be compensated for by tilting the pelvis and the functional result be entirely satisfactory. Experience with several thousand fracture cases has convinced us that while perfect anatomical reduction should be our ideal, and every justifiable means used to obtain it, still a satisfactory functional result is what the patient wants and his life and limbs should not be endangered to obtain beautiful X-ray plates.

TIME OF REDUCTION AFTER THE FRACTURE

If the case is seen within the first 12 hours, or if no undue swelling has taken place, reduction is done immediately and a plaster cast applied. We have had no serious consequence due to swelling after the cast has been applied. In several partially united cases where it was necessary to use considerable manipulative force and traction, it has been necessary to split the cast. There is no difficulty in determining when this is necessary if the patients are given the ordinary postoperative attention due any cast case. In cases where there is excessive swelling present when the case is seen, we postpone the reduction to make the manipulation easier and to prevent the cast from becoming loose when the swelling recedes. We have found no difficulty in making sufficient extension to secure end-to-end apposition of the fragments when the muscles are thoroughly relaxed under an anæsthetic. Compound fractures are, of course, kept in an extension splint until all chance of infection has subsided.

We have used the method of treatment just described in all our acute fractures of the shaft of the femur, numbering 130 cases, and have done open reductions only in cases of solid union in malposition or non-union. There have been 23 cases of the latter type, making 153 cases upon which this report is based. The series has been divided into two groups, children and adults, as the difficulties of treatment and the end-results are decidedly different. The series does not include fractures of the neck of the femur, intertrochanteric or peritrochanteric fractures or epiphyseal separations, as we feel that these offer different surgical problems and should not be confused with fractures of the shaft. Each group has been subdivided into simple fractures, compound

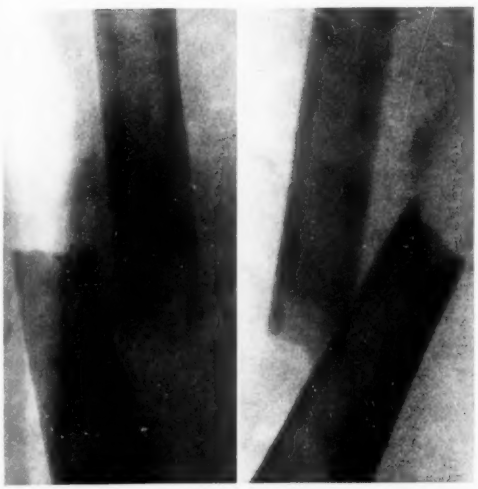

Fig. 3, A. Anteroposterior and lateral views of fracture of middle third of femur in an adult.

fractures, and fractures requiring open operative treatment.

Fifteen years has been arbitrarily chosen as the dividing line, as at about this age the physical development changes from the child to the adult type. Of the 153 cases sixty-seven fall into the child group, the ages ranging from 5 weeks to 15 years. The location of the fracture was in the middle third in 60 per cent and 20 per cent each in the upper and lower third of the shaft; 80 per cent were of the transverse type, 15 per cent spiral or oblique and 5 per cent green stick. Forty-eight, or 70 per cent, were in boys; and 19, or 30 per cent, in girls. This is in marked contrast to the adult group when only 4.7 per cent were in women. This, however, is to be expected as the physical activities of boys and girls are very much the same, while in adult life relatively few women are engaged in hazardous occupations. The number of automobile accidents may change this ratio.

The second, or adult group, consists of 86 cases, ranging from 16 to 71 years. Here again the middle was the common site of injury and the transverse the usual type of fracture, the percentage being practically the same as in children.

The results have been classified as perfect when there was solid union with end-to-end apposition of the fragments and no angulation or shortening; good when there was less than 1 inch overlap or slight angulation, but with a satisfactory functional result; poor when there was non-union or excessive deformity (shortening over 1 inch or bad angulation).

Fig. 3, B. Anteroposterior and lateral views of same patient as in *A*, 4 weeks later, showing good reduction and early callus formation.

SIMPLE FRACTURES

A—Children. Fifty-seven cases were of the simple acute type and were treated by the routine reduction and plaster cast. Fifty, or 87.7 per cent, were perfect; 6, or 10.5 per cent, were good, and 1, or 1.8 per cent was poor. The case classed as poor was in a boy 14 years old, who had a delayed union with three-fourths inch overlap. One month after he began to walk he had a second fall with refracture. As union was again delayed after 6 weeks in cast, an open reduction was done to secure end-to-end apposition, and to freshen the fragments. Solid union was obtained. We have experienced very little difficulty in obtaining a satisfactory reduction and in holding this reduction afterward by means of the usual cast. Prompt and adequate callus has been the universal rule in simple fractures, and good firm union has usually taken place at the end of 2 to 3 weeks when the original cast is removed for inspection. The callus is still malleable enough to allow slight correction in position, if necessary. Many of these cases belong to the unfortunate middle class of patients who are not wealthy enough for private rooms in a hospital for from 5 to 8 weeks, or not poor enough to seek advantage of the charity ward. A child in a cast can be taken home, even to neighboring

Fig. 4, A. Anteroposterior and lateral views showing fracture of lower third of femur in an adult.

cities, after about 10 days, without fear of displacing the fragments. This, of course, is out of the question if the fracture is being treated by the extension method, which requires daily, and often, hourly adjustments. Children all stand casts very well, and we have never had to remove one for intercurrent or complicating disease. Immobilization of joints over a long period of time is not a factor of serious importance in children. Many of the cases here classed as "good" will eventually become perfect, for young growing bones have a marked ability to straighten out overlaps and angulations and even to make up by compensatory overgrowth a moderate amount of shortening. A most interesting article has been published in which the author[1] states that fractures of the long bones in children often cause a stimulation in growth which may result even in the affected limb becoming longer than the normal. We have observed one such case. Period of disability is from 6 to 10 weeks, open reduction necessary in only 1 case. No non-unions.

B—Adults. This group includes 54 cases, ranging from 15 to 71 years. Here, again, the middle third was the common site of injury and the transverse the usual type of fracture. Thirty-two, or 60 per cent, were perfect; 19, or 35 per cent, were good, and 3, or 5 per cent, were poor. One case died before an attempt at reduction was made, from a fractured skull received at the same time as the fracture of the femur. This gives a good functional

[1] Truesdell, E. D. Ann. Surg., 1921, lxxiv, 498–500.

Fig. 4, B. Anteroposterior and lateral views of same patient as in *A*, 4 weeks later, showing good reduction and early callus formation.

result in 95 per cent of the cases, which compares favorably with any results reported. There were no cases of non-union, and it was not necessary to do an open reduction in a single case which we received for treatment in the acute stage, that is, within 3 weeks after the injury. Of the 3 cases classed as poor, 2 were old men of 60 and 62 years. In these the casts broke allowing slight angulation and 1½ inch shortening, and the general condition of the patients was so poor that it was not advisable to do further reduction or open operative work; in one the knee became so stiff as permanently to impair the function of the leg. Another patient, originally classed as a non-union recently returned with a good leg. He presents so many points of interest that his case is worth reporting in detail.

The patient, a robust man of 71 years, received an oblique fracture of the middle third of the femur in an automobile accident. He was treated immediately with the routine cast, end-to-end reduction was obtained, but because of the fact that he was very obese, the position could not be held and a 1-inch overlap occurred at the end of 12 weeks in casts. There was a slight amount of callus thrown out but still free motion between the fragments. Wassermann was negative. Operation was deferred because of his age and he was placed in a walking brace from the foot to the waist with a Thomas ring. He returned after 4 months

Fig. 5, A. Anteroposterior and lateral views showing fracture of lower third of femur in an adult.

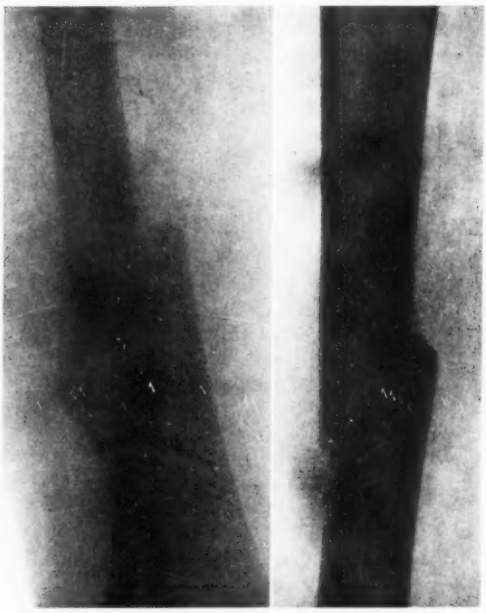

Fig. 5, B. Anteroposterior and lateral views of same patient as in *A*, showing final result, good reduction. Perfect functional result.

with solid union, good alignment and only 1 inch shortening. With this amount of motion between the fragments at the end of 12 weeks it appeared as if it were going to be a case of permanent non-union. The fact that it has united simply shows what may be accomplished by nature even in an old subject, if sufficient time is allowed and proper splinting employed.

It will be noted that 19, or 35 per cent, of these cases, are classed as good, that is, they had an overlap and shortening of not over 1 inch or a very slight angulation. Alignment is easily controlled or corrected if the case is properly followed by observation and X-rays. Overlapping, however, has proved a much more difficult problem to control, especially in the smooth oblique type, where it is often impossible to maintain end-to-end apposition, and an overlap of one-half to three-fourths inch occurs, resulting in permanent shortening and a slight increase in the period of disability. The functional result, however, is entirely satisfactory, as the patient is able to resume any type of occupation and soon learns to walk without a limp. It may be that in the future we will employ open reductions in this particular type of case, but at present we prefer a slight shortening to the risks and uncertainty of open reductions. Sixty per cent perfect and 35 per cent good gives 95 per cent satisfactory functional results. This is a very good prospect to offer a man who has had so serious an injury.

COMPOUND FRACTURES

Here, of course, the first consideration is the infection which is liable to occur, the reduction of the fracture being temporarily a secondary consideration. It is an equally bad mistake to understate the dangers of an infection and attempt any strenuous manipulation for reduction, causing increased damage to the soft parts, or to overestimate the danger and do an immediate extensive débridement, unnecessarily traumatizing the soft parts and sacrificing bone fragments which may be needed to bridge the defect between the fractured ends and prevent shortening. With the case in a hospital under careful observation, adequate drainage can be established at any time. Débridement was of invaluable service in war injuries, where it might be necessary for a patient to go for several days without dressings while being transported to the rear, where doctors were changing daily, and where the incidence of gas bacillus infection was very high, but these conditions should not apply in civil practice. Examination of our records of compound fractures of all bones shows that 75 per cent healed

Fig. 6, A. Anteroposterior view showing malunion of 2 years' duration of middle third of femur.

Fig. 6, B. Anteroposterior view of same patient as in *A* after open reduction. Anteroposterior alignments perfect. The lateral view shows anteroposterior angulation, but solid union. Excellent functional results, with only three-fourth inch shortening.

without infection. In femurs, 45 per cent healed *per primam*, included in which are 5 cases of gunshot fractures with the usual comminution. There was only one gas bacillus infection in our compound fractures of the femur. This was fatal, as is usual when the thigh is involved. Of course, it is perfectly obvious that in some cases, when there is extensive laceration and crushing of the soft parts, infection is inevitable, and the proper débridement may be immediately done.

TREATMENT

The routine method of treatment in compound fractures is to clean up the external wound with iodine, to apply a sterile hot wet dressing of ½ to 1 per cent carbolic solution, and to place the limb in a Thomas splint with traction. Fifteen hundred units of tetanus antitoxin is given on admission. If no infection has occurred at the end of 10 days the fracture is reduced in the usual manner, and a plaster cast applied. In no case has an infection flared up after this procedure.

If infection occurs during the first 10 days, adequate drainage is established, either by enlarging the original wound or by counter incisions. Fragments of bone are removed only when they have been thrown off as a definite sequestra. It is a well established fact that bone fragments, and even bone grafts, may live and be incorporated into a callus even in the presence of an active infection.

RESULTS

There were six compound fractures in children and fourteen in adults, all of which present very much the same problems of treatment, and will

Fig. 7, A. Anteroposterior and lateral views of fracture of lower third of femur in an adult.

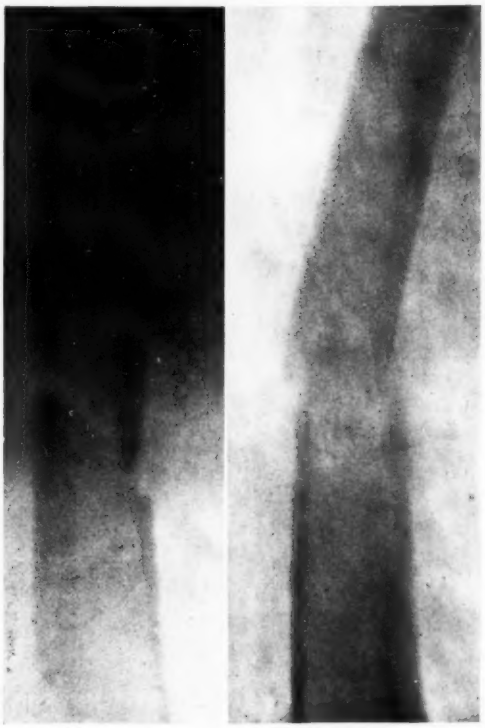

Fig. 7, B. Anteroposterior and lateral views of same patient in cast 2 weeks after reduction, end-to-end apposition, fragments locked, good alignment.

be discussed together, the results depending chiefly upon whether or not infection occurred. Eight cases healed *per primam*. The result was excellent in six, and good in two. Nine cases became infected and the results here depended upon the severity of the infection, and upon the amount of bone lost by comminution and necrosis. Three cases had less than 1 inch shortening and healed after a few weeks' drainage. Four cases had over 1 inch shortening, three developing a chronic osteomyelitis requiring secondary operations, and permanently impairing the function.

Two cases were fractures complicating an active osteomyelitis, as pointed out in a previous paper,[1] union occurs in fractures through an involucrum very much the same as in normal bone, except that the production of callus is somewhat delayed. Both cases were in children, one obtaining solid union in 2 months, and one in 4 months.

One case died of an extensive gas bacillus infection 2 days after injury.

In no case did non-union occur.

OPEN REDUCTIONS

As previously stated in this paper, no open operative reductions were done on the acute fractures in this series. There were 23 open reductions, 5 in children and 18 in adults. These came for treatment at periods of time varying from 3 months to 7 years after the original injury, and had either non-union or union in malposition. An effort to determine the cause of the bad results showed that most of them had been treated in the home with poor and insufficient splints, or simple extension, and no real attempt at reduction or fixation had been made.

Of the 5 children, 3 had vicious union, and 2 non-union. Both non-unions were in older children, 13 and 15 years old, who had received practically no treatment, resulting in overlap and bad angulation, and wide separation of the ends of the fragments with scar tissue healed across the gap. In the first, a case of 6 months' duration, the scar was dissected out, the ends of the bones freshened and notched, and a cast applied. In the second case of 2 years' duration, there was considerable atrophy of the bone, so a sliding graft

[1] J. S. Speed. An analysis of one hundred and sixty cases of osteomyelitis with end results. South M. J., 1922, xv, 721–727.

Fig. 8, A. Anteroposterior view of fracture of middle third of femur in a boy.

Fig. 8, B. Anteroposterior and lateral views of same patient as in *A*, 3 months later, showing solid union and perfect position.

was done as an extra precaution. Both promptly united, and an excellent result was obtained. In the three vicious unions, an osteotomy was done through the point of union, the ends of the fragments mobilized, freshened, and notched together. It was necessary to resect about ¾ inch in one case to obtain end-to-end apposition. It is well to remember that bone grafts in children are rarely indicated and that abundant callus formation can be depended upon, even in old fractures, if reduction is maintained.

The adult group consists of 18 cases, 7 non-unions, 10 vicious unions, and 1 delayed union in malposition. Age was of no consequence, as most of the cases were under 30 years. The middle one-third was the site in 60 per cent, practically the same as the incidence of fractures in this part of the shaft. All of these cases present a serious surgical problem, for any method of operative treatment adopted is fraught with difficulties and dangers, and operative treatment is the only one that offers the possibility of a good functional result. The ingenuity of the surgeon and the endurance of the patient are often taxed to the utmost. Most of the cases are of a long duration, with from 1 to 4 inches overlap and permanent contractures and shortening of the soft parts, and often extensive scar formation around the ends of the fragments. Atrophy of the shafts and eburnation of the ends of the fragments add to the difficulties. After the fragments have been mobilized it is dangerous to attempt to overcome more than 1½ inches shortening by stretching of the soft parts, due first to the added shock to the patient and second to the extreme tension under which the fragments must be locked together. The two operative deaths in this series were due chiefly to the prolonging of the operation and the increase of the operative shock by efforts to overcome excessive shortening. (A two-stage operation with a preliminary osteotomy and gradual traction extension has not proved satisfactory.)

All operations should be performed under a tourniquet, as it is impossible to control bleeding without a prohibitive loss of time, and even then enough blood will be lost to add materially to the shock. Sufficient skilled assistance is an essential.

The advantages and disadvantages of the various operative procedures used for treating malunions and non-unions is too comprehensive a subject to be discussed in this paper, but a brief summary will be given.

Of the 10 cases of malunion, simple osteotomy at the site of union, with freshening and notching of the ends of the fragments and resection of sufficient bone to secure end-to-end reduction, was done in 8 cases. All obtained solid union, and 5 with less than 1 inch shortening, and 1 with over 1 inch shortening and some angulation. In this case, the general condition of the patient after operation required removal of the cast. The degree of shortening was dependent upon the amount of bone necessary to resect, because of the original overlap. There were no operative deaths. In one case we were able to gain about 2½ inches in length, but as a general thing 1½ inches was all that could be safely gained.

Autogenous bone grafts were used in all 7 cases of non-union, both to secure certain internal fixation, and as a method of stimulating callus formation, as these cases had already proved to be deficient in this respect. The massive tibial graft, fixed in position with autogenous bone nails and reinforced by pieces of medullary bone rich in osteogenetic tissue [1 and 2] proved to be the most satisfactory type of graft. Four cases obtained excellent results. One case became infected and the graft was lost, but he obtained solid union after 6 months. This case had originally been a compound fracture, but had been entirely healed for over 8 months, and pre-operative baking and massage had failed to produce a reaction. It simply proves what has so often been pointed out by operators doing reconstructive war surgery, that an old infection may be lighted up, even after many months of apparent inactivity.

There were two operative deaths in this group, both cases of several years' standing with marked overlapping of the fragments. The fatal post-operative shock in each was due to prolonged efforts to overcome the excessive shortening. We have adopted a working rule that 1½ inches is a safe amount of shortening to overcome, and 1 hour and 30 minutes the outside time limit for any operative procedure on a femur.

One is often asked what will be the period of disability in a fractured femur. We have found that the average period of time, in an adult case which does well, is about 4 months. However, in many cases where there is a malunion or delayed union or infection the disability may extend over a period of one or two years, or may even be permanent. Ten per cent of the acute adult group were totally disabled for over 6 months.

[1] M. S. Henderson. Treatment of ununited fractures. Ann. Surg., 1921, April, 73–487.

[2] Campbell, Willis C. The treatment of ununited fractures. Am. J. Surg., 1923, January.

CONCLUSIONS

1. Fractures of the shaft of the femur in children properly treated give excellent results.

2. Callus in children is usually exuberant, and non-union even in the presence of infection or malposition is very rare.

3. Young growing bones have the ability to correct even marked deformities.

4. Immediate reduction and plaster cast is the ideal method of reduction in children because (1) of the uniformly good results, (2) the ease of handling and caring for the patients and the certainty that lack of co-operation, on the part of the child, cannot displace the fragments as often happens with the traction treatment.

5. In adults the plaster method, properly used, gives us as good, or better, results than any other method.

6. Simple fractures should be reduced immediately after injury.

7. Early mobilization of joints and massage of the soft tissues is of great importance in all fractures, but satisfactory reduction and union should not be endangered by too great an enthusiam in this respect.

8. Compound fractures of the femur will heal without infection in 50 per cent of the cases.

9. Non-union is due chiefly to malposition.

10. Open reductions are rarely indicated in acute fractures of the femur.

11. Autogenous bone grafts are the best method of internal fixation in connection with open reductions; internal fixation is rarely indicated in children, even in non-unions; it is indicated in malunions in adults, when reduction is difficult to maintain; it is always indicated in non-unions in adults.

12. Fractures of the femur give long periods of disability and unless properly treated are liable to result in permanent impairment.

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THE OPERATIVE TREATMENT OF CEREBELLAR ABSCESS OF OTITIC ORIGIN[1]

Important Mechanical Factors

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PREMISES. Experience has shown (1) that in a considerable number of the cases the cerebellar abscesses are not reached during operation because of their positions; (2) that many abscesses which have been successfully drained at operation, have at postmortem been found to have been but imperfectly evacuated, because of the irregular shape of the abscess cavity; and (3) that a very small percentage of the total number operated upon ultimately recover; for although many observers report as high as 50 to 60 per cent, a large compilation of cases gives but 10.5 per cent of recoveries.

However, an analysis of the postmortem records in 131 cases of cerebellar abscess would apparently show that the position of 81 per cent of all cerebellar abscesses of otitic origin should be amenable, at least theoretically, to surgical treatment.

By directing attention to the mechanical factors encountered at operation, and by presenting an operative technique adapted to meet them, I hope will lead (a) to a decrease in the number of unsuccessful explorations and (b) to an increase in the percentage of ultimate recoveries.

SYNOPSIS

Mechanical factors. 1. The position of a cerebellar abscess depends largely on the (a) path by which the infection reaches and enters the dura, and (b) the pathological process by which the infection is conveyed into the dura.

2. The difficulty in obtaining an exposure through a clean area sufficient to admit of proper inspection is due to (a) the small size of the cerebellum and (b) the position of the lateral sinus. These anatomical limitations may be further increased during operation by (c) excessive cerebellar herniation.

3. The increased intracranial pressure from the abscess with the associated disturbance of the cerebrospinal fluid system circulation occasions a displacement of the brain stem downward into the foramen magnum; and the increased size of the affected cerebellar hemisphere causes a dislocation of the cerebellum and the contiguous brain stem away from the median line.

In view of the immediate fatal effect which may follow further cerebral displacement during operation, the operative attack should be planned (1) to enter the abscess at its nearest approach to the dura, so that the manipulation may cause the least possible damage to the cerebellar tissue; (2) to prevent excessive cerebellar herniation by adapting the surgical manipulations to the abnormal position, and (3) safely to reduce the increased intracranial pressure.

Operative technique. These conditions may be met theoretically by conducting the exploration through an enlarged, clean operative field. To obtain this it is necessary (1) to perform a primary complete uncovering of both cerebellar hemispheres, continued laterally on the affected side until the homolateral sinus is fully exposed; (2) to obliterate the sinus by the invulsion of its outer wall into its lumen in its upper portion and by an encircling ligation below; and (3) to incise the dura through the sinus and to enlarge it anteriorly or posteriorly, thus exposing an area otherwise inaccessible which allows exploration, inspection, and proper evacuation through a clean field.

THE PREDOMINANCE OF AN AURAL ORIGIN IN CEREBELLAR ABSCESS

The postmortem records of 131 cases of cerebellar abscess compiled by the author show the origin in 123 cases; of which 103 (about 83 per cent) were of aural origin.

The importance of a pre-operative diagnosis of the pathological process. A knowledge of the method by which the infection reaches the cerebellum is of surgical importance, as a pre-operative diagnosis of the exact pathological process present enables the surgeon, in a certain proportion of cases, to visualize the site of the abscess sufficiently to make the operation essentially therapeutic rather than explorative.

1. *Adjacent cerebellar abscess* of aural origin may be a result (a) of direct extension of the suppurative process. With such an origin the abscess is always situated contiguous to the area of bony caries; a fistulous tract extending from the inflamed dura into the abscess cavity within the brain. Or it may result from a (b) retrograde thrombophlebitis (or perivasculitis) of a cere-

[1] Abstract of paper read before the Tenth International Otological Congress in Paris, July 18, 1922.

bellar vein, the abscess being situated generally within the cerebellar substance itself in the neighborhood of the area of primary bony involvement. Here the internal surface of the dura usually is not affected microscopically, there being no adhesion between it and the cortex. The cerebellar cortex when involved becomes so from *extension of the abscess outward*.[1]

An adjacent cerebellar abscess can be diagnosed in a large number of cases by a "vague" chill followed by a gradual course interrupted frequently by a "latent period" characteristic of localized cerebral suppuration.

2. *Non-adjacent cerebellar abscess.* When the abscess is situated at a distance from the original area of suppuration in the ear, it may be caused by the aural infection having given rise to a thrombophlebitis of the sigmoid or petrosal sinus, which in turn conveys the infection to the cerebellum. Here the intradural invasion may originate (a) from direct extension through a necrosis of the inner wall of the sinus, in which case the abscess is situated chiefly on the cerebellum (superficial brain necrosis). More commonly, however, lateral sinus thrombosis causes cerebellar abscess (b) by an extension of the infectious thrombophlebitis of the sinus into one of the small cerebellar veins emptying into it, which latter is the immediate occasion of nutritional death of the cerebellar tissue and abscess formation. When of such an origin the cerebellar abscess is generally situated in the cerebellar substance itself.[2]

A clinical pre-operative diagnosis of intercurrent (tertiary) cerebellar abscess is possible at times by a careful study of the history revealing a gradual onset of cerebral symptoms preceded by evidence of a blood stream infection (chills, irregular temperature, positive blood cultures, etc.).

To the group of non-adjacent abscesses also belongs metastatic cerebellar abscess. These abscesses originate from an infective nidus, which, after being liberated from a distant focus and circulating free in the blood stream, is suddenly deposited in a cerebellar cortical or subcortical vein, causing obliteration and infective nutritional death of cerebellar tissue. A metastatic abscess[3] is generally associated with an apoplectiform type of onset of cerebral symptoms.

Lastly, cerebellar abscess associated with aural suppuration may be of traumatic origin; from explorative punctures of the dura, from blows on the head, or from operative proceedings on the mastoid. The trauma in operations on the mastoid (especially in the presence of increased intracranial pressure) may cause a lowered vitality and hæmorrhage into the cerebellar tissue, the suppurating ear supplying the infection necessary for abscess formation (17, 9, 10, 11).

All of these authors report the abscess as a result of trauma to the head, the primary focus of infection being distant from the brain—in Sabares' (17) case in the leg, in Gibbs' (9) case in the lung, in Mairet, Durand, Seigneurin, and Monez' (10) case in the antrum of Highmore, and in Massary and Girard's (11) case in the pleura.

I am persuaded that the concussions associated with chiselling during a radical mastoid operation is not infrequently the cause of cerebellar abscess; for how otherwise can be explained the large number of reported cerebellar abscesses which have immediately followed a radical mastoid operation. There is also evidence that hæmorrhage within the substance of the brain contiguous to an area of suppuration can be the origin of an abscess. In Fronk's (8) case "the probable cause of abscess was rupture of a small cerebral vessel due to or coincident with the firing of a gun; the resulting clot passing through the usual liquefying process and later becoming infected through the blood stream from some secondary focus, most probably from carious teeth."

THE OPERATIVE IMPORTANCE OF PRE-OPERATIVELY DIAGNOSING THE ROUTE OF INVASION OF THE CEREBELLUM, WHETHER BY THE PETROUS PYRAMID OR THE LATERAL SINUS

It is a clinical fact that in the large majority of cases cerebellar abscess of aural origin is situated in the vicinity of the seat of primary infection in the bone (Trautman triangle, labyrinth), or of the thrombosed lateral sinus; consequently a diagnosis of the path through which the suppuration ultimately reaches the cerebellum from the external parts may be of the greatest surgical assistance. Our present knowledge of cerebellar

[1] For both of these types of abscess the writer previously has suggested the designation "adjacent" (secondary)—secondary, because the intradural pathological process is *secondary* to the primary infective process in the bone (middle ear, antrum, labyrinth, or perilabyrinth) and "adjacent" because the abscess is invariably located adjacent to the primary focus. Eagleton, W. P., Brain Abscess; Its Surgical Pathology and Operative Technic. Macmillan Company, 1922.

[2] As the thrombophlebitis may extend to any part of the sigmoid or transverse sinus involving in its course the superior or inferior petrosal; or as it may extend even into the sinuses of the opposite side, and may give rise, at any place, to a retrograde thrombophlebitis of a small intracerebellar vein emptying into the sinus, the resulting cerebellar abscess can be situated on any surface or in any part of the cerebellum. For abscesses of such origin the designation *intercurrent* (tertiary) has been suggested—"tertiary," because the abscess follows a secondary infective process via the sinus thrombosis; and "intercurrent," because the infective process is carried from the vicinity of the primary suppuration in the ear by an intercurrent infection of a large venous trunk. *Loc. Cit.*, p. 95.

[3] I have seen two cases in which a metastatic abscess originated from a suppurating ear, one abscess being situated in the opposite hemisphere of the cerebrum. In both cases the onset was apoplectiform.

localization is so rudimentary that the surgeon can only attempt a tentative pre-operative diagnosis of the position of the abscess as located either (1) in the surgical anterior cerebellar triangle, or (2) in the posterior two-thirds of the posterior fossa.

In many cases such a differential diagnosis may be accomplished by a careful study of the history and a complete neurological examination which must be associated with functional tests of the static and auditory labyrinths, with blood and cerebrospinal fluid examinations, and with previous operative findings. Generally, when the labyrinth can be definitely established as the tract of infection, the abscess is situated in the anterior surgical triangle; but when the abscess originates from sinus thrombosis, its location generally is either in the cerebellar hemispheres or on one of the cerebellar surfaces.

In a large number of cases even this crude localization is impossible, although there is no doubt that the majority of cerebellar abscesses of otitic origin are primarily in the anterior surgical triangle.

FREQUENCY OF LABYRINTHINE ORIGIN OF CEREBELLAR ABSCESS

The records of the 125 autopsies[1] show that the labyrinth was the cause of cerebellar abscess of aural origin in 57 cases (46 per cent), of which 32 (25 per cent) were by "preformed ways"; thrombophlebitis of the lateral or transverse sinus was the cause in 42 (34 per cent); an associated labyrinthitis and sinus thrombosis occurred in 13 (10 per cent), and caries of the mastoid preceded the cerebellar suppuration in 25 (20 per cent). In many of the last mentioned cases the labyrinth was undoubtedly affected; but as no proper examination of the labyrinth was made functionally during life and none at postmortem the real causative lesion of the abscess was overlooked.

Experience leads me to believe that 60 per cent of all cerebellar abscesses originate in the labyrinth. And as cerebral abscesses but very rarely originate in the labyrinth, because the physiological connections of the labyrinth are entirely within the posterior fossa, the presence of a dead labyrinth with unmistakable symptoms of brain abscess is presumptive evidence that the intracranial suppuration is probably situated in the cerebellum.

Thus, by a pre-operative diagnosis of the path of infection the surgeon may be able to decide whether the cerebellar abscess is situated (1) on or near the anterior surface of the cerebellum (when the infection entered through the posterior surface of the petrous pyramid) or (2) in or on the posterior two-thirds of a lateral hemisphere (when the infection originated from the lateral sinus).

Associated cerebral and cerebellar abscess. The diagnosis of an adjacent temperosphenoidal abscess does not necessarily exclude an associated cerebellar abscess as statistics show that in about 3 per cent of all cases there is present an abscess in both the middle and posterior fossæ. Moulinguet (13) encountered 3 cases of abscess cavity in both the cerebrum and cerebellum in 6 cases diagnosed as temperosphenoidal. Damade (6) in 459 brain abscesses found 11 (2.5 per cent) in both the cerebellum and cerebrum.

High mortality from cerebellar abscess. In spite of the general belief, the percentage of recoveries following the evacuation of cerebellar abscess is still very low, although individual operators report a fair percentage. Niehsmann (16) in a large collection of reported cases found only 10.5 per cent recoveries in contradistinction to the much lower mortality of adjacent tempero-sphenoidal lobe abscess, in which the recoveries are from 35 to 50 per cent; and in the hands of William McEwen, 80 per cent. Niehsmann (16) reports 8 cases of cerebellar abscess with no recoveries; and Boot (1) reports 5 cases of this type of abscess with one recovery.

The discouraging results of operative treatment are largely due, I believe, to the surgeon's uncertainty regarding the presence of a cerebellar abscess during the period in which operative interference is most favorable, that is, during the "latent stage," after the development of a capsule but before the onset of marked signs of central compression; as well as to the impossibility of localizing the abscess surgically without considerable damage to the cerebellar tissue. To this must be added the frequency with which explorations have failed to disclose the abscess, which latter has occasioned an operating timidity among surgeons.

With the object of ascertaining the accessibility of cerebellar abscess by the usual methods of exploration, an analysis of the situation of the abscess in the cerebellum as recorded in the literature of cases coming to postmortem has been attempted.

Surgical deductions from the analyses of postmortem reports of the various situations of cerebellar abscess. In the recorded autopsy reports of 131 cases, the location of the abscess is sufficiently defined to be roughly available in 93 cases.

[1] Eagleton, loc. cit., p. 220.

TABLE I

RECOGNIZED SITUATIONS OF CEREBELLAR ABSCESS IN RELATION TO THE USUAL ROUTES OF OPERATIVE APPROACH

Situation of abscess in cerebellum in 131 autopsy records in which the position of the abscess is stated with sufficient definiteness to justify analysis.

	Cases	Per cent
A. Total number which would probably have been accessible to exploration from front of sinus	41	44
1. On or near anterior surface of cerebellum	30	
2. "Whole of lateral hemisphere"	11	
B. Total number probably accessible to exploration if approached from behind sinus	24	26
3. In posterior two-thirds of cerebellum	23	
4. On lateral surface of cerebellum	1	
C. Total number probably inaccessible by either route of exploration	11	12
5. On or near lower surface	6	
6. On or near lower and mesial surface	3	
7. On or near posterior and mesial surface	1	
8. On or near upper surface	1	
D. Total number positively unlocalizable by either route of exploration	17	18
9. In middle lobe	3	
10. Opposite lobe	2	
11. Bilateral	2	
12. Multiple abscesses	10	
Total	93	100

The situation of the abscess would have allowed evacuation and drainage from in front of the sinus in 41 cases (44 per cent), while such a method of approach would probably have failed to reveal pus in 52 (56 per cent). Punctures behind the sinus probably would have revealed pus in 24 (26 per cent), but, even if thus successfully located, imperfect evacuation would surely have followed such an approach so that even were the surgeon enabled to diagnose the position of the abscess by a careful study of the mode of invasion, he could approach the abscess at its nearest point to the dura in but 70 per cent of the cases if the technique were limited to the present accepted method of approach, while of these, in only 44 per cent of the total would the position of the dural opening have allowed proper evacuation and drainage. Of the remaining 56 per cent the described situation warrants the belief that the position in the posterior two-thirds of the cerebellar hemisphere would have rendered extremely improbable the location of the abscess even by repeated punctures from in front of the sinus in 23 (25 per cent). Twenty-eight or 30 per cent probably could not have been located by either method. The position, in these 28 cases, on the lower, mesial, upper, or lateral surfaces or opposite lobe, would almost surely have precluded the possibility of the abscess having been reached by either approach in 17 cases (about 18 per cent) and the position and type of the other cerebellar abscesses positively precluded successful intervention by either method in 12 (about 13 per cent); 10 were multiple and 2 bilateral.

On the other hand the described situation warrants the belief that 81 of the 93 cases (over 87 per cent) were amenable, at least theoretically, to localization and complete evacuation had a method of exploration been adopted allowing a dural incision of sufficient size for complete inspection and exploration of the cerebellum.

In these 87 per cent possibly successful cases, if the operative attack is to conform to the accepted conditions necessary for successful surgical intervention, viz., that the exploration, evacuation, eradication and drainage should follow the original tract of infection and enter the abscess at its nearest approach to the dura; 41 (about 51 per cent) of them should have been evacuated at some point on the anterior surface of the cerebellum; 35 (about 43 per cent) at some point behind the lateral sinus; 5 (about 6 per cent) from beyond the median line or the opposite cerebellar hemisphere.

Bourgeois (4) collected from the literature the reported cases of cerebellar abscess, and analyzed the position of 63 of them as follows:

	Cases	Percentage
"*Anterior*" (by which term he designates those situated in the anterior part of cerebellar fossa in relation with the posterior surface of the petrous bone)	15	24
"*Anterior external*" (in "juxtaposition" with the sinus)	27	43
"Antero-internal" (in relation to the internal auditory meatus)	10	16
"Posterior external" (posterior to the sinus)	4	6
"In the vermis"	6	9½
"In the flocculus"	1	1½
	63	100
"Description not precise enough for analysis"	20	

1. *Increased intracranial pressure.* In cerebellar abscess the intracranial pressure is generally increased. This increased pressure is the result of the increase in the cerebellar contents from (a) the abscess itself, and from the displacement of affected lobe beyond the median line into the

cerebellar fossa of the opposite side, blocking the normal cerebrospinal fluid pathway, thus giving rise to (b) an obstructive hydrocephalus. The hydrocephalus is further aggravated by an increased secretion of cerebrospinal fluid from irritation of the inflammatory process. Personal experience and experimental evidence show that cerebellar abscess, because of its suppurative nature, is always accompanied by internal hydrocephalus of variable degrees, independent of any obstruction of the iter. However, an examination of the autopsy reports previously referred to record only 28 instances of enlarged ventricles in 128 cases of cerebellar abscess.

Surgical importance of not suddenly disturbing the abnormally placed cerebellar tissue. The intracranial pressure of the posterior fossa is normally maintained by the cerebrospinal fluid circulatory system; which also is the chief agent in protecting the vital centers of the medulla from injury by the surrounding bony wall of the foramen magnum, especially when the medulla is herniated downward through the foramen. Normally, impact of the medulla on this bony ring is prevented by the cerebrospinal fluid in the cisterna pontis in front, the cisterna magna behind, and laterally by the cerebellar tonsils on the inferior surface of the cerebellum; which latter project through the foramen magnum for variable distances, "in some cadavers reaching only to the upper border of the posterior arch of the atlas, and in others to the upper border of the lamina of the axis (Moore, 12)." The fluid in the basal cisterna acts as a waterbed for the brain, lifting the brain-stem and cerebellum upward. The direction of the maximum intra-cerebellar pressure is normally backward, upward and outward in the axis of the lateral lobes of the cerebellum toward the tegmen cerebelli, away from the median line and the posterior surface of the petrous pyramid, to which the cerebellar surface is more or less fixed by nerves or vessels entering the internal auditory meatus and the venous sinuses. It is because of this fixation that incision of the dura on the anterior surface of the cerebellum (behind the posterior surface of the petrous pyramid and internal to the sinus) is usually attended by little herniation. On the other hand, incision of the dura external to the sinus, over the lateral lobe, is generally associated with uncontrollable herniation, which prevents proper inspection at operation and subsequent drainage.

2. *Cerebral displacement.* In addition to the increased pressure, the enlarged size of the affected cerebellar hemisphere displaces the vermis, pons, and medulla, which normally occupy the median position of the posterior fossa, crowding them laterally beyond the median line and downward into the foramen magnum. The displacement alters in a fundamental way the normal circulatory mechanism, which is necessary for the proper functional activity of the cerebellum and the brain-stem (7, 2).

In cerebellar abscess both the increased intracranial pressure and the brain-stem displacement is generally tolerated, chiefly because the displacement is of gradual development permitting the stretching of the fixed parts of the brain, the vessels, and the nerves. If, however, the resistance to further herniation of the medulla into the foramen magnum, is suddenly removed, sudden death from pressure upon the vital centers may follow. Or, what is probably more frequent, when the increased pressure plus the brain-stem displacement causes a sudden and severe circulatory disturbance of the vital centers with rupture of the stretched vessels, embarrassment of the respiration results followed at a longer or shorter period by death. I believe that it is the circulatory disturbance and not the foraminal herniation which is probably the most frequent cause of respiratory paralysis. Borries (2) collects 47 cases of respiratory paralysis in brain abscess (32 cerebellar) and comes to the conclusion that respiratory paralysis is the result of a combination of increased intracranial pressure and circulatory disturbances from abnormal cerebral displacement.

I have seen four sudden fatal respiratory paralyses in brain abscess (two cerebellar, one in the occipital lobe, and one in the temperosphenoidal lobe). Small punctuate hæmorrhages into the pons and medulla were noted at autopsy in one of the cerebellar cases. No especial importance was attributed to these hæmorrhages until later, when a similar autopsy finding was made in two cases of cerebral tumors. These patients had died suddenly. In both, a lumbar puncture had been performed, and in one an operation had preceded lumbar puncture. In one the autopsy report reads: "*Hæmorrhages in the parenchyma of the pons*, where there are numerous transverse streaks of clotted blood, which were being compressed by the transverse fibers of the pons. There is also slight piarachnoid hæmorrhage about the course of both superior cerebellar arteries. These hæmorrhages were probably terminal, due to rupture of the transverse branches of the basilar artery, possibly from sudden disturbance of the intracranial pressure by the lumbar puncture." (Harrison Martland, personal communication.)

Fig. 1. Pontine hæmorrhage and death the result of sudden alteration in the position of the brain from lumbar puncture in a case of cerebral displacement from temperosphenoidal lobe tumor. (Autopsy and photograph by Dr. Fred Sutton.)

In case of a temperosphenoidal lobe tumor in which a lumbar puncture was performed, the autopsy revealed multiple hæmorrhages in the pons (Fig. 1).

Because of the brain-stem's displacement and the associated liability of respiratory paralysis from it, ventricular puncture (or a lumbar puncture), should never be performed in cerebellar abscess; not at least unless the surgeon is prepared to evacuate the abscess immediately or to freely incise the dura; as any sudden alteration in the position of the displaced brain-stem may cause rupture of the stretched vessels and sudden death.

The disturbance of the already overtaxed central control of the circulatory system is the cause of the cessation of respiration when ether is being administered, which has resulted fatally in numerous instances. The immediate cessation of respiration on the administration of ether in a recent fatal case has persuaded me that a suspected cerebellar abscess, with known increased intracranial pressure should be operated upon under local anæsthesia whenever possible; at least, until the dura is freely exposed. In several cases in which all other means had failed, respiration was restored by the immediate evacuation of the abscess (3,14) Borries (3) collected 4 new cases in which immediate evacuation of the abscess was followed by resumption of respiration.

Technical surgical requirements in exploration for cerebellar abscess in the anterior surgical triangle. Both physiological and mechanical factors and clinical experience demand that the exploration of a cerebellar abscess, originating from infection of the petrous pyramid, should be through a dural opening, situated as far forward as possible, in order (a) to follow the route of infection and (b) to lessen the cerebral herniation. Accepted surgical principles also require that the dural opening be large enough to permit of (c) adequate inspection and evacuation, and that the operative procedure be performed (d) through a clean field; otherwise an unsuccessful exploration may result in a fatal suppurative meningitis. In addition the inspection and evacuation must be conducted so that (e) no further disturbance is transmitted to the already displaced and functionally endangered brain-stem.

The disadvantages of the usual methods of operative treatment when the abscess is probably situated in the anterior cerebellar triangle are as follows when:

1. *Incision and evacuation is in front of the lateral sinus.*

Even when an abscess has been located, the dural surface which can be obtained is too small to permit complete eradication by cleansing under inspection or subsequent adequate drainage; and as a large proportion of cerebellar abscesses have "fingerlike" prolongations, this method should not, in my opinion, be employed; although probably the largest number of successes have resulted from this procedure. Mouret and Cazejust (15).[1]

[1] Mouret and Cazejust give an illustration of a cerebellar abscess with three compartments communicating by small openings which immediately became obliterated on the evacuation of the pus from the outer chamber, and thus did not permit evacuation through a drainage tube introduced into the most external cavity. At postmortem it gave the appearance of separate abscesses and could easily have been so regarded clinically.

Fig. 2. Sketch showing relation of walls and cavity of descending portion of lateral sinus with two dural attachments preventing approximation by ligation. From Wm. McEwen's *Atlas of Head Sections*, Macmillan, 1893. Plate 41. Horizontal section ⅜ in. above middle of external auditory meatus and passing through the mastoid antrum.

Fig. 3. Sketch showing pear-shaped form cavity of transverse sinus and the relation of its walls with the three fixed dural surfaces preventing obliteration by encircling ligature. From McEwen's *Atlas*, Plate 24, "Coronal Section, 1⅜ in. posterior to auriculo bregmatic line."

The difficulty of proper exploration, through evacuation, or adequate drainage (because of the smallness of the area between the sinus and the posterior pyramid), has been successfully overcome in a few cases by:

2. *Destruction of the labyrinth is followed by exploration of the cerebellum in front of the sinus.* My personal experience and an examination of the literature reveal, however, that an anterior approach, even with the destruction of the labyrinth, has frequently failed to locate the abscess, although one of considerable size existed (18).

However, if the whole of the cerebellar fossa is exposed and the dura freely incised, all parts of the cerebellum may be inspected, and the abscess localized and thoroughly evacuated.

3. *When the labyrinth had been destroyed Bourguet (5) enlarged the anterior homolateral area by a double closely applied encircling ligation of the sinus with entrance to the cerebellum by the sinus between the ligatures and through the sinus walls.*

All these methods, however, fail to fulfill the surgical requirements of a clean operative approach, as the cerebellum is entered through an infected area. In the operative treatment of cerebellar abscess of the anterior surgical triangle, the method of Bourguet is undoubtedly the most important addition of recent years, but is attended by the following objections:

1. A double ligation of the sinus (except very low in the descending portion) is attended with great technical difficulties (Figs. 2, 3), especially if the sinus is large, or has abnormally communicating sinuses as is frequently the case (19, 20).

2. This operation is conducted through an infected area.

As a logical development of Bourguet's method of double ligation, and in an attempt to overcome the technical difficulties of a sinus ligation while keeping within an area as yet not infected, I have practiced and advocate the following: beginning the operation by uncovering the dura over both cerebellar hemispheres, followed by an *exposure of a lateral sinus* of the affected side. A clean area is obtained by *approaching the sinus from behind* after which the sinus is *obliterated by the invulsion* of its outer wall into its cavity, just below the knee; and by an encircling ligature in its lower portion. This procedure will admit of a *free incision of the dura through the walls of the sinus, with enlargement anteriorly or posteriorly into the contiguous dura surface, and this in many cases in an uninfected area.*

My experience with this method is still too limited to warrant the statement that the mortality from cerebellar abscess will be improved by its adoption, but theoretical consideration and the high mortality by other methods certainly justify its trial in suspected cerebellar abscess especially during the "latent period," when a positive diagnosis of cerebellar abscess is impossible and when consequently exploration by the recognized methods may not be warranted because of the risk of infection of the meninges.

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A NEW SUPRAPUBIC PROSTATIC ELEVATOR

By ROBERT EMMETT FARR, M.D., F.A.C.S., Minneapolis, Minnesota

THE trend of modern surgery is toward a better exposure of pathology during operation. The classical method of performing suprapubic prostatectomy through a small incision, while supporting the gland from below by one or more fingers in the rectum, is seen less and less. Many surgeons now perform suprapubic prostatectomy without the aid of the rectal finger, thus greatly simplifying the maintenance of an aseptic technique. A realization of the virtues possessed by a perfect visualization of the interior of the bladder is gradually spreading throughout the surgical world and the urologist is adopting this principle to some degree.

The more extended use of local anæsthesia has had a marked effect in this regard. The advantages of adequate incision and exposure of the interior of the bladder, transfixion and elevation of the enlarged gland, permitting of enucleation similar to that employed in dissections of the neck for the removal of tuberculous glands or thyroid adenomata should be obvious to everyone. We have taken advantage of this principle in all of our bladder work during the past 10 years.

The employment of a preliminary sacral anæsthesia combined with a complete infiltration block of the suprapubic field, tilting of the operating table, elastic retraction of the edges of the incision, and perfect illumination of the relaxed air-distended bladder offer to the surgeon the same opportunity for work upon the interior of the bladder as that presented by the fresh cadaver. Trauma may thus be minimized and hæmorrhage may be prevented by the application of surgical principles as all structures are brought directly within the field of vision.

In Surgery, Gynecology and Obstetrics, November, 1920, the writer described a prostatic elevator designed for the purpose of facilitating

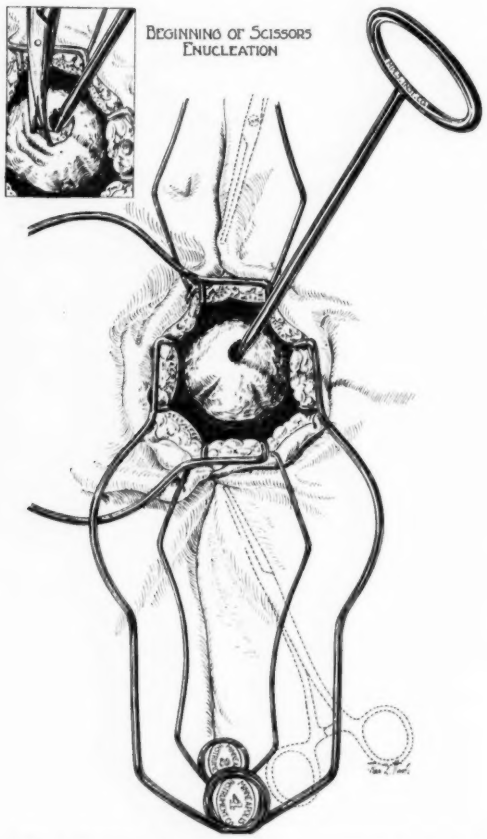

Fig. 1. Suprapubic prostatectomy—prostatic elevator in action—surface view.

Fig. 2. Suprapubic prostatectomy—prostatic elevator in action—sagittal view.

the removal of the prostate through the suprapubic incision. While this instrument has proven a most valuable aid and has more than fulfilled the writer's expectations, it is difficult to manufacture, therefore expensive, and there is, in the case of small prostates, the possibility of the finger coming in contact with one of its points during the process of enucleation.

The instrument herein described presents all of the advantages and none of the disadvantages of the previous one. It is inexpensive and extremely efficient. Its shaft is small, therefore giving the minimum obstruction to one's vision. When introduced into the gland, it brings the latter absolutely under the surgeon's control, it interferes in no way with finger enucleation and, like the previously described instrument, effectually obviates the necessity of inserting the finger into the rectum.

The point of the screw (insert Fig. 1) is introduced into the posterior wall of the prostatic urethra and the instrument screwed boldly into the gland, the dimensions of which have been previously estimated, until its shaft only presents. The direction in which the screw is introduced being at an acute angle with the prostatic urethra, brings its distal portion well posterior (Fig. 1). One may now enucleate the gland under direct vision and as a rule, the use of curved scissors or a curved hook will almost do away with the necessity of introducing the hand into the bladder (Fig. 2).

AN ILLUMINATING DEVICE FOR THE VAGINAL SPECULUM[1]

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THE instrument described and illustrated herewith is designed for illuminating the vaginal canal, fornices, cervix, etc., by means of an efficient, direct, stationary illumination, suitable and available for examination, treatment and operative procedures.

Heretofore, direct vision was obtained by means of a head-mirror, or a self-made contrivance such as a flexible stationary lamp, necessitating adjustment at each examination to the needs of the individual patient and the requirements of the occasion. These invariably have proven unsatisfactory, particularly in the complete examination of the vaginal canal, etc., for not infrequently important details would be overlooked, particularly in the examinations made at the patient's home, where the surgeon is constantly laboring under a marked disadvantage.

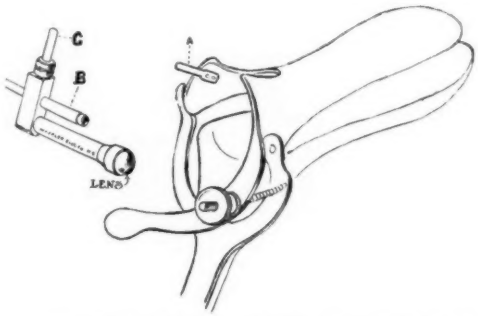


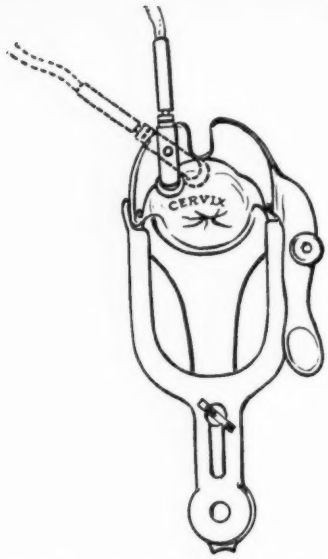
Fig. 1. Illuminating device showing lens, tunnel *B*, for attachment to pin *A* on speculum. *C*, Connection for light.
Fig. 2. Vaginal speculum with pin *A*, for the attachment of the illuminating device.

It is generally conceded that the essential requisites for direct illumination are the following: (1) adequate illumination, (2) the light away from contamination by secretions, (3) non-interference with the lumen of the speculum. Obviously these requisites have not been attained by illuminated specula heretofore employed.

The instrument now presented, in addition to overcoming all the difficulties previously encountered, successfully accomplishes each of the foregoing requisites. It provides abundant illumination for visual examination, treatment, and operation. Thus effective illumination is assured, regardless of the position, size or shape of the patient, and without the inconvenience and annoyance of repeated, continuous and awkward changes of the direction of the rays of light. Its design and construction insures against the contact of the light with the secretions and prevents encroachment upon the lumen of the speculum.

Description. The ordinary bivalve speculum is used. To this is fitted a small circular pin *A* placed on a line with the long axis of the speculum. This attachment is fixed to the upper movable lip

[1] From the Department of Gynecology, New York Post-Graduate Medical School and Hospital, New York.



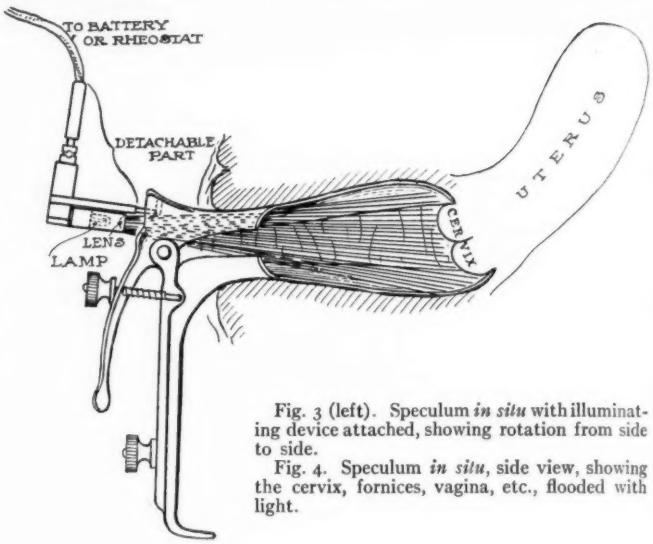


Fig. 3 (left). Speculum *in situ* with illuminating device attached, showing rotation from side to side.

Fig. 4. Speculum *in situ*, side view, showing the cervix, fornices, vagina, etc., flooded with light.

one-half inch to the left of the median line and does not interfere with the original space left for the clitoris.

One of the essential features of this instrument is the light carrier, having a focusing lens so adjusted as to concentrate the rays of light on the cervix and abundantly illuminate the entire vaginal canal. The tunnel *B*, of the carrier, fits on the pin *A* thus making a swivel connection for rotation of the light from side to side. This entire attachment projects less than one-half inch from the anterior lip and in no way interferes with the lumen of the speculum. It is a detachable unit, easily removed when not in use thereby permitting of its interchangeability with many instruments. This assures and facilitates thorough sterilization. The coupling of the cord from the source of current, points to the abdomen away from any vaginal secretions or contamination.

The cord and rheostat or batteries are stock types supplied by manufacturers and constitute a part of the equipment of practically every physician and surgeon. The source of current may be through a rheostat, portable batteries, or even a small hand battery ordinarily used with eye or ear instruments.

Method of procedure. 1. The speculum is inserted and left loose.

2. The cord is attached to the light and the proper degree of illumination obtained by increasing or decreasing the amount of current through the rheostat or batteries.

3. The light is then attached by means of the tunnel *B* to the pin *A* attached to the left side of the anterior lip of the speculum.

4. The speculum is then rotated and by this direct illumination, adjustment is faciliated.

5. Thus the treatment, examination, or such procedure as may be indicated, is carried on under a constant illumination, without need of changing the position of the source of light.

6. With the completion of the treatment, etc., the light is detached from the speculum, the latter removed from the patient and is ready for sterilization. The light carrier may be attached to successive specula without interruption.

Accomplishments. 1. The vaginal canal is flooded throughout with a constant, continuous, and direct illumination at all times.

2. The lumen of the speculum is unobstructed by the light attachment.

3. One light unit being interchangeable with many instruments, a sterile vaginal speculum is always available.

4. The source of light is far enough away from the field to prevent contamination from secretions, but insures abundance of illumination.

5. The entire instrument is negligible in bulk and weight and obviously convenient for satifactorily examining patients at their homes or places other than the surgeon's office.

6. Attachments are stock accessories, readily obtainable and ordinarily applicable to any type of vaginal speculum.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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NOVEMBER, 1924

SURGERY IN CHRONIC ULCER OF THE STOMACH AND DUODENUM

IN recent surgical literature, much attention has been given to chronic ulcer of the stomach and duodenum. There has been a tendency in some quarters to advocate resection of ulcers of the duodenum, which were formerly treated, and very successfully, by gastro-enterostomy. Many years have been devoted to perfecting the technique of gastro-enterostomy, which, in the hands of experts, at the present is practically without danger. Careful, delicate handling, avoidance of tension, the short loop, and proper arrangement of the size and position of the opening, have brought this operation to such perfection that hæmorrhage has almost been eliminated, the formerly dreaded vicious circle is no longer to be feared, and the operation in experienced hands is both simple and safe. It changes the chemistry of the stomach contents, diminishing acidity. The larger and more inflamed a duodenal ulcer is, the better the patients do. They increase in weight during their stay in the hospital, the clinical picture is changed for the better, and, according to the latest statistics (Mayo), about ninety per cent are permanently relieved. On the duodenal side of the pylorus, we are free from danger of cancer. Gastro-enterostomy is a far less serious and difficult operation than most resections. Why then substitute the more dangerous for the simpler procedure? "Safety First" is as good a slogan in the abdomen as on the highway. It is, nevertheless, true that when the ulcer is characterized by serious or repeated hæmorrhage, resection may be necessary, and, when the parts are movable and can be drawn well out, should be seriously considered, for it is not unknown for hæmorrhage from an ulcer to continue after a gastro-enterostomy; and a resection, of course, deals directly with and removes the bleeding surface. Where the ulcer is extensive and runs well down on to the duodenum, however, it may be difficult because of the depth to which the dissection may have to be carried, the amount of inflammatory thickening and adhesions, and the consequent difficulty of closing the duodenal stump. Whosoever resects under these circumstances takes a serious risk. In several instances the writer has seen resections of the pylorus undertaken in cases in which it seemed to him that gastro-enterostomy would have cured the ulcer, but because the pylorus was movable and the ulcer small, a resection was undertaken and skilfully performed, but the patients died. It is a very unpleasant experience to lose a patient from doing more than you feel may have been necessary, and the possibility of a secondary resection, which might have been done if the patient was not cured, also makes radical procedures at first less imperative.

The walls of the stomach are so thick, it is

often so easy to handle and so well adapted to hold stitches, that we are tempted to do too much. With ulcers on the gastric side of the pylorus, if close to it and causing obstruction, my own results as to cure by gastro-enterostomy have been most favorable. Resection may be performed here on account of the danger of cancer, which, from the statistics of some large clinics, seems to be great. However, I do not believe it great enough to justify taking large risks in these ulcers close to the pylorus.

The advocacy by von Haberer of extensive resection followed by gastro-duodenal anastomosis it seems to me has done a good deal of harm. That the pyloroplasy of Finney, which he has always advocated as opposed to gastro-enterostomy, has not in all cases been entirely satisfactory, is brought out by the fact that he now advocates a method of excision by which the cut end of the stomach is attached to the side of the mobilized duodenum, the end of which has been closed by a purse-string suture. Would one care to be subjected to this procedure, even in skilful hands for the cure of a small ulcer of the duodenum? C. H. Mayo has recently described what seems a very satisfactory method of resection in smaller ulcers of the duodenum, but, as I understand, it limits its application to cases in which hæmorrhage is present.

The case of large ulcers of the lesser curvature is different, both on account of the lesser probability of cure by gastro-enterostomy and the definite danger of cancer. Here resection in some form is, of course, necessary, and here the cautery operation of Balfour combined with gastro-enterostomy has greatly reduced what used to be a high mortality. These cases require the greatest skill and judgment, and in my opinion should be referred by the average so-called abdominal surgeon to those men who have demonstrated special skill in this field. Only special skill and experience can teach what is safe and efficient. What is safe in skilled hands is dangerous for men not specially qualified. The very best proverb in this connection is the old Greek adage, which among others was inscribed for guidance of the multitude over the entrance to the Temple of Apollo at Delphi, *mā̆den agan*, which may be interpreted: "Never attempt what is beyond your capacity," or "do not bite off more than you can chew."

F. B. LUND.

SYSTEMATIZED OPERATING ROOM ASSISTANCE

IN visiting a large number of surgical clinics in America and in foreign countries, the activity of the internes who serve as operating room assistants has furnished material for interesting observation. I have found that in some clinics the young men give intelligent and really valuable service, in other clinics they are of little or no use, while in still another group of clinics, the internes are a liability rather than an asset.

I have made the further observation that internes with the same training, men who have been classmates in the same medical school, and who later serve in different surgical clinics may render excellent service in one clinic, while in another clinic the service may be quite inferior.

I believe that the difficulty does not lie in the character, habits, intelligence, or qualifications of the internes, but in the interest which the surgical head of the clinic takes in his internes, and especially in the ability of the chief not only to develop a definite system with which the internes can become familiar, but also to adhere willingly to carefully planned methods combined with a plan of regular conferences.

In my clinic the essential principles have been formulated in a concise set of rules which I discuss with the entire staff of internes at regular intervals at our weekly conferences, and always at the first conference after the admission of a new member of the interne staff.

Nothing seems more valuable in developing an efficient interne staff than weekly conferences and adherence to a definite system of work.

The following rules have been in use for many years in my clinic at the Augustana Hospital.

1. Concentrate your attention upon the operation to facilitate work and eliminate infection.

2. Waste not a moment's time from beginning of anæsthesia until the patient is returned to bed.

3. Bear in mind the patient's condition before, during, and after operation.

4. Anticipate the steps of operation throughout operation. Determine reason for each step.

5. Constantly avoid traumatizing the tissues.

6. Touch tissue with instruments, not with hands.

7. Apply forceps without jamming tissues or pulling upon them.

8. Retract tissues gently, not violently. Guard against slipping of retractors.

9. Press gauze sponges against bleeding surfaces. Do not rub them.

10. Handle only the instruments you apply personally. Do not hand them to others.

11. Never pull sutures tightly enough to cause pressure necrosis.

12. Place needle at right angle to wound grasping the same amount of tissue on both sides.

13. Work accurately, but rapidly. Waste no time.

14. Use the same care against infection in dressing wounds as in the actual operation.

15. Use the same care against infection in re-dressing wounds as in the actual operation.

16. Do not manipulate or press wounds during dressing.

17. Develop an antiseptic conscience, which you carry with you all the time.

18. Develop an anti-waste conscience, which you carry with you all the time.

19. Teach younger assistants, and nurses, to avoid waste of every kind.

20. Do not let patients wait in the halls before anæsthetic is begun.

21. Plan tomorrow's operations, carrying all details in your mind.

22. Have a clear idea of the history, diagnosis, proposed treatment, and pathology in each case.

23. Take a personal interest in each individual patient from the time of admission to the time of discharge.

24. Observe carefully any error in anything connected with treatment or organization, and report at conference.

25. Follow the standardized plan of work, being, however, constantly alert to discover improvement in technique or plan of work. Do not introduce new technique until it has been carefully thought out by you and considered in conference. A. J. Ochsner.

MASTER SURGEONS OF AMERICA

SAMUEL PRESTON MOORE

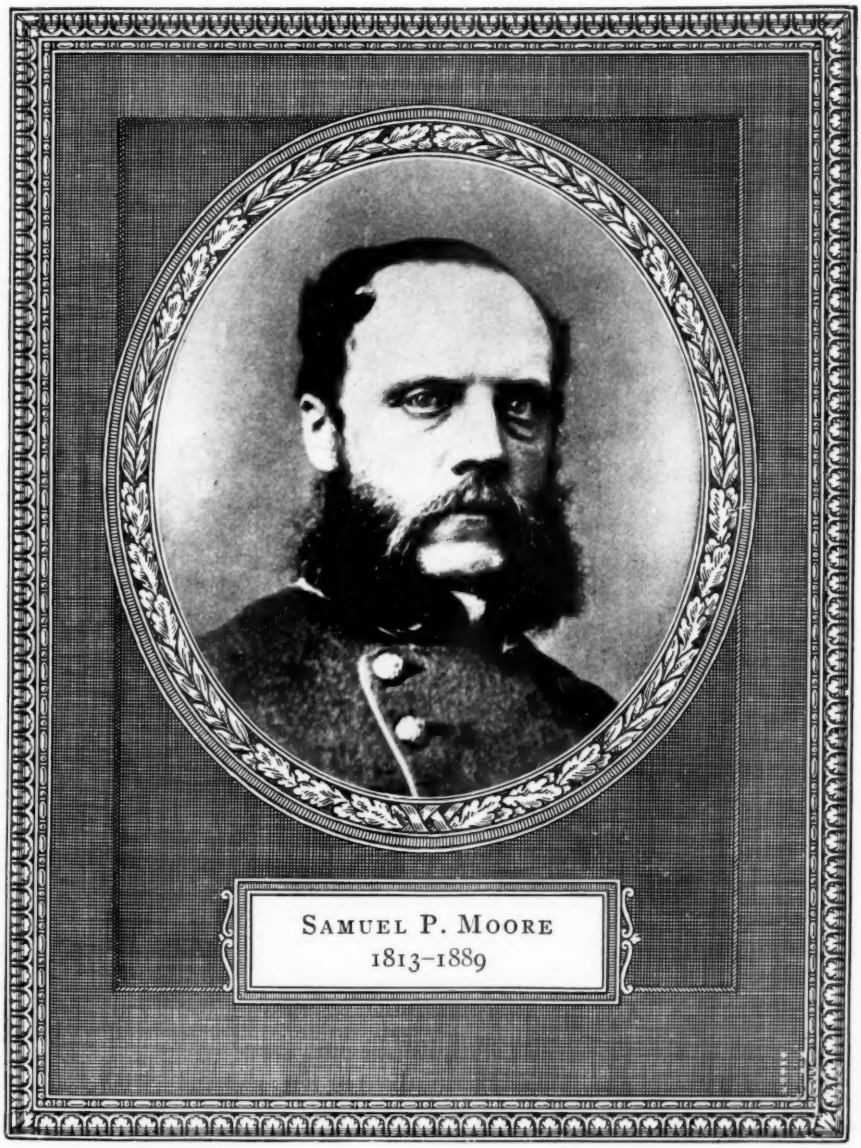
SAMUEL PRESTON MOORE was born in Charleston, South Carolina, in 1813. His father and mother were Stephen West and Eleanor Screven (Gilbert) Moore. His grandfather and grandmother were Samuel Preston and Susanna (Pearson) Moore. His first American paternal forebear was Dr. Mordecai Moore, the physician of Lord Baltimore, the founder of Maryland.

Dr. Moore was educated in the city of his nativity. Graduating in medicine in 1834, he was appointed assistant surgeon (with the rank of captain) in the United States army, March 14, 1835, when he was twenty-two years of age. His service in the old army, lasting for 26 years, was a very varied one, and prepared him well for the execution of the onerous and most responsible duties to which he was called when in 1861 he threw in his lot with his fellow-citizens of South Carolina.

On July 30, 1861, Dr. Moore was assigned to duty in Richmond as acting surgeon-general of the Confederacy, and his name was, on November 29, 1861, presented to the Provisional Congress of the Confederate States for confirmation.

Probably the most difficult work that he had at the start was to secure a sufficient number of competent surgeons. The troops in the field were all volunteer troops who had been allowed to select their own officers, medical officers included, and their selections were not always the best. In the enthusiasm of the early days of the war many doctors had volunteered for service as soldiers, not as surgeons. Some of these were officers, and some even in the ranks. Proper laws applying to the medical personnel were slow in getting passed. But in course of time medical examining boards were provided for, which improved conditions wonderfully. It is estimated that there were, first and last, about one thousand surgeons and two thousand assistant surgeons in the Confederate army and navy—both branches of the service being looked after by the one medical department.

These cared for in the 4 years of the war six hundred thousand Confederate troops and about two hundred and seventy thousand Federal prisoners of war, the latter of whom had to be looked after for a much longer period than normally would have been the case because of the stern policy of the Federal government



SAMUEL P. MOORE
1813–1889

late in the war of permitting no exchange of prisoners, a policy that resulted in the crowding at one time of thirty thousand prisoners into a space at Andersonville intended to accommodate only ten thousand, and in a distressing death rate in most of the Confederate prisons—but one not equal, it must be said in justice to the Confederate surgeons and their chief, who strove manfully to reduce it, to the death rate in the Federal prisons, the percentage of deaths in the former being about 8.3 and in the latter 12. It is said that the Confederate surgeons cared for during the war more than three million cases of wounds and disease.

Moore's next most difficult work was the erection of an adequate number of hospitals in properly selected places throughout the South—such hospitals as in the late great World War would have been called base hospitals.

A continuing and increasing difficulty was the securing of medical and surgical supplies for these base hospitals and for field and camp. Though the Federal blockade pressed heavily, the medical department of the Confederacy did not cease at any time during the war from getting in large quantities of supplies from abroad. In addition, there was a good amount of trade with Mexico, and there was always a vast amount of smuggling along the extended borders of the North and the South. Another source of supply was capture. The result of all this was that there was at no time an absolute dearth of medical supplies. Many Confederate surgeons said after the war that they never failed to have an ample supply of the three most important drugs: quinine, morphine, and chloroform.

From the beginning of the war Dr. Moore occupied himself with the question of substitutes, and with the study of the medicinal qualities of indigenous plants. A rather amusing correspondence is preserved—and printed in the "Records"—carried on between Surgeon-General Moore and one of the generals in the field in reference to the use of quinine, he maintaining that the general had erred in issuing an order that quinine should be given to the troops as a prophylactic. He held that it should be reserved for use in cases of actual sickness and that a preparation of native plants should be relied on for prophylactic purposes. His standby was the following: "Dried dogwood bark, 30 parts; dried poplar bark, 30 parts; dried willow bark, 40 parts; whiskey, 45 per cent strength; 2 pounds of the mixed bark to 1 gallon of whiskey. Mascerate 14 days. Dose for tonic and anti-febrifuge purposes, 1 ounce three times a day."

As with medicines, so with hospital furniture, bedding, and other necessary articles, it was in course of time found necessary for the medical bureau to assume direct control of the manufacture of them. Competent operatives had to be secured for the work. Disabled soldiers were used as far as practicable, but what with his laboratories, his distilleries, and his establishments for making equipment, he had to have detailed many men, experts in their line, whom commanding officers were loath to give up and anxious to get back into ranks. The surgeon-general was compelled to wage a constant warfare to keep up his organi-

zation. What he was striving for until the very end was permanence of assignment of men to the work under his control and their exemption from all military duty. He maintained that they should not be expected to bear arms even in extreme emergency.

Dr. Porcher says of him in an address before the Association of the Survivors of the Confederate Surgeons of South Carolina at Columbia, South Carolina, November, 1889:

"Within his domain, which was a very extensive one, he had absolute power and the *fiat* of an autocrat; the Emperor of the Russias was not more autocratic. He commanded and it was done. He stood *in terrorem* over the surgeon, whatever his rank or wherever he might be—from Richmond to the trans-Mississippi, and to the extremest verge of the Confederate States. And though appearing to be cold and forbidding, we do not think that Surgeon Moore was cruel, arbitrary, or insensible to conviction. We have ourselves experienced some of his stern rulings, which were afterwards fully compensated for."

One respect in which the surgeon-general, in Dr. Porcher's opinion, erred, was in his opposition to the granting of furloughs except in extreme cases. Dr. Porcher maintained that the mental outlook of the average Confederate soldier was different from that of the average soldier in any other army; that the Confederate soldier was, when depleted by wounds or sickness, peculiarly subject to an extreme degree of nostalgia that became dangerous in its effects. "The promise of a furlough was found to be superior to the whole pharmacopœa, and would literally rescue a sick or wounded soldier from the jaws of death." This peculiarity of the Southern soldier may in some measure account for the higher mortality in the Northern prisons than in the Southern prisons. Moore, accustomed in the old United States army to men on the average much less sensitive and high-strung than were the Confederate soldiers, was a foe to easy furlough.

Dr. Moore did not overlook the value of the meeting from time to time of men of the same profession for the discussion of topics of mutual interest and for gaining inspiration from contact with each other. In August, 1863, there assembled in Richmond, under his auspices, a large number of surgeons, who organized the "Association of Army and Navy Surgeons of the Confederate States." He also endeavored to have supplied in a measure the lack of professional literature throughout the South by encouraging the publication of *The Confederate States Medical and Naval Journal.* This came out monthly in Richmond from January, 1864, through February, 1865. In short, he seems to have neglected none of the known methods for consolidating the members of the medical and surgical profession in the South in his effort to make of them a most efficient instrument in the conduct of the war.

The last report made by Surgeon-General Moore to the Secretary of War is dated February 9, 1865. It is a special report in reply to a circular sent out by

the Secretary asking for a report from each department head as to the means on hand for carrying on the war. It was generally felt that conditions were becoming critical. One would not suppose this, however, from a perusal of the reports, which, if not optimistic, are certainly determined. Dr. Moore replied, in part: "The department has on hand, of some articles, a twelve months' supply, of others a limited supply, but if allowed to retain its skilled employees at the various laboratories, purveying depots and distilleries, and to import medicines freely through our lines in Mississippi and Alabama, no fear need be entertained that the sick and the wounded of the army will suffer for the want of any of the essential articles of the supply table."

At the close of the war Dr. Moore elected to remain a resident of Richmond. Since he had sufficient means to supply the wants of himself and family, he did not endeavor to practice his profession to any great extent, preferring, after the arduous labors he had performed, to pass the remainder of his life in comparative ease. Being, however, a very public-spirited citizen, he served his adopted city and State well as a member of at least two boards. One of these was the executive board of the Virginia Agricultural Society, of which he became a member in 1874, continuing until 1881. Since he always took his duties seriously, his services in connection with the State fairs were valuable. His was a striking figure in the crowds at the exhibitions.

His services were even more valuable as a member of the city school board, from 1877 until his death. It is said of him that every morning he, with military precision, went to the office of the superintendent of schools for consultation. He advocated the teaching of vocal music in the schools, but the medical man in him came out plainly in the arguments he made that the singing would greatly develop the lungs of the pupils. He was the author or instigator of a series of eye-sight tests, with the purpose of having the teachers give pupils of defective vision advantageous seats with reference to the blackboards and windows. On the day before he died he was at the superintendent's office as usual, and talked in the most interested way of the forthcoming high school commencement, in making arrangements for which he had spent much time. This picture of Moore giving of his best in his declining years to the service of youth reminds us of the rôle played in a broader way by his great chieftain, Robert E. Lee.

Dr. Moore was a member of Lee Camp Confederate Veterans and never gave up his interest in Confederate affairs. According to his own wish, no flowers were placed on his coffin or on his grave at the time of his interment, but on his breast was laid a small Confederate flag, and to the lapel of his coat was pinned a Confederate badge. He died on May 31, 1889, in the early morning, and was buried on June 2, in the afternoon, in Hollywood Cemetery. His comrades and the citizens of Richmond and of the South universally recognized that a most notable figure had passed.

H. R. McILWAINE.

TRANSACTIONS OF SOCIETIES

CHICAGO GYNECOLOGICAL SOCIETY

REGULAR MEETING HELD MAY 23, 1924, DR. CHARLES S. BACON, PRESIDING

SPECIMENS SHOWING IMPLANTATION ADENOMYOMA; AND HÆMORRHAGIC CYST OF RIGHT OVARY OF ENDOMETRIAL TYPE WITH ADENOMYOMA IN THE POUCH OF DOUGLAS

DR. CAREY CULBERTSON: *First specimen.* I have a specimen here which demonstrates better than any I have seen the so-called implantation adenomyoma, which is similar to the adenomyoma of the rectovaginal septum 4 cases of which Dr. Goldstine reported some time ago.

This is a uterus containing a fibroid in the posterior wall, a small one, and on the serous surface of the fibroid is a cap of soft spongy material, membranous in appearance, about ½ inch in thickness, sections of which I will show you.

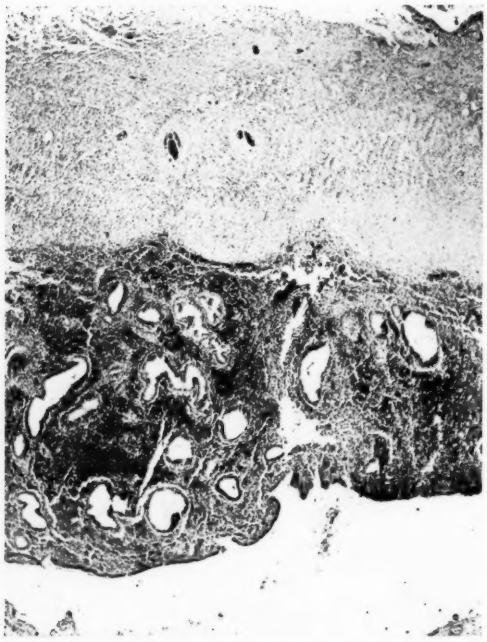


Fig. 1. Section of implantation adenoma (Sampson) on the serous surface of a uterine fibroid, showing a glandular and interstitial development resembling a mucous polyp of the corpus uteri.

The specimen was taken from a nullipara, 46 years of age, who came into the hospital complaining of menorrhagia which she had had for 7 years, excessive bleeding for 7 to 10 days every month. At 39 years of age she began flowing irregularly, the periods lasting from 1 week to 30 days. Two years ago she began to skip periods and flowed every 2 to 8 weeks. She missed Februrary but flowed in March and April, 1924. The last period prior to operation was on April 3.

Sections (Fig. 1) show that this material is in all respects like a large polyp of the mucosa of the corpus uteri. The glands are definitely endometrial in type and there is an abundant interstitial development. There are no hæmorrhagic areas.

Second specimen. This specimen is in the form of microscopic sections, the gross material not being large enough to bring before you. I will give a history of the case and then show the slides.

This material (Figs. 2, 3 and 4) is from the pelvis of a young woman who has been under observation since last December. She gave a history of having been married 4 years, of having never been pregnant and of having dysmenorrhœa, but the thing that brought her under observation was the pain in the lower abdomen. She sometimes thought it was a little more severe on the right side. There was no menstrual irregularity whatever. In December she had some sort of an operation which I judge was nothing more than a dilatation and curettage and a test of tubal pregnancy. The test of patency was positive she was told and my findings at examination showed no great evidence of pelvic disease. She continued to have pain and dysmenorrhœa and came under my observation this month.

I operated upon her last week after having her under observation for about 10 days to determine whether operation was warranted. There was no induration in the pelvis such as Dr. Goldstine reported as present in his cases a few months ago. She, herself, suggested that I remove her appendix. At the operation I found a hæmorrhagic cyst in the right ovary which was ruptured, the ovary being adherent at the level of the uterosacral ligament, with some infiltration of these ligaments on either side. The peritoneal surface of the pouch of

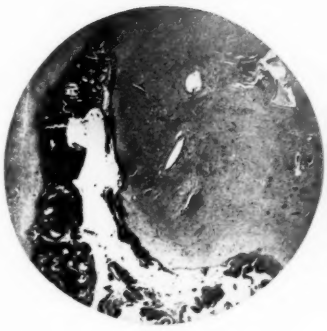


Fig. 2

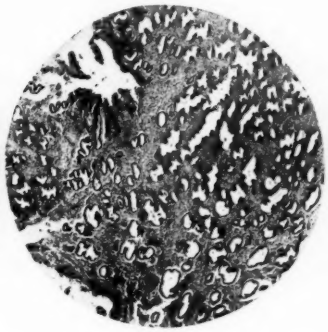


Fig. 3

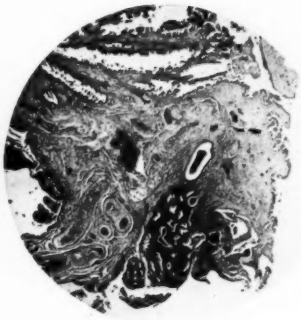


Fig. 4

Fig. 2. Section of right ovary; hæmorrhagic (chocolate) cyst showing membrane endometrial in type lining the cyst cavity.

Fig. 3. Section of membrane from the pouch of Douglas, showing tissue in all respects similar to endometrium, with hæmorrhagic areas suggesting an active menstrual reaction.

Fig. 4. Section of the Morgagni cyst attached to the fimbriæ of the left tube, showing glandular material, endometrial in type on its surface.

Douglas was covered with a thick membranous material which could be wiped away with the finger or with gauze, leaving only a slight bloody oozing after its removal. Both tubes were free and normal; the left ovary was normal and from the left tube a small hydatid of Morgagni hung suspended by a pedicle and was adherent in the cul-de-sac on the left side, being immersed in the membranous material. The first section on the screen is from the right ovary and shows a hæmorrhagic cyst containing structure that is endometrial in type, the tubules and stroma resembling those of the uterine mucosa of the premenstrual or active menstrual stage. The second section is that of the material from the pouch of Douglas which grossly resembles scrapings of a hyperplastic endometrium. This section shows a structure in all respects similar to that in the ovary. Hæmorrhagic areas are seen which strongly suggest the active menstrual stage of uterine mucosa. The third section is from the tubal hydatid. On its surface we see again the same type of tissue. This membranous development in the posterior cul-de-sac did not rise above the level of the uterosacral ligaments but did involve the anterior rectal wall and its disposition strongly suggests a spill of material from the ruptured ovarian cyst and implantation on the peritoneal surface.

DISCUSSION

DR. EMIL RIES: Dr. Culbertson characterized the specimen as due to implantation. The development of the glandular structures and of the stroma goes beyond anything I have conceived possible in implantation. According to Sampson these cases are implantations of the uterine mucosa escaped through the tube into the abdominal cavity. How an implantation of seminecrotic uterine mucosa can occur to such an extent is almost beyond comprehension.

A great discussion is going on at present as to whether such structures are due to implantation or to serosal epithelium which is able to produce gland-like structures. The gland-like structures of this tumor might be of either origin. But the stroma is the great stumbling block.

DR. CAREY CULBERTSON: I should have said that in this specimen the sections of the uterine wall did not show adenomyoma of the uterus, that is an adenomyomatous development and continuation of the uterine cavity. That is a very different thing. In that respect it differs from the earliest cases of adenomyoma of the rectovaginal septum as reported by Stevens, Cullen, MacCarthy and several others.

As Dr. Ries has said, there are two explanations, one offered by Sampson of implantation and transplantation and the other that of a metaplasia developing from the serosa. Both of these explanations are theoretical and it seems to me that it is quite as easy to believe one as the other, perhaps not quite as easy as Dr. Ries says. I showed the specimen and called it an implantation adenomyoma, simply taking that term from the work of Sampson which is in the American literature.

DR. MARK T. GOLDSTINE: I would like to ask Dr. Culbertson if he thought the chocolate cyst was a factor in the dysmenorrhœa. I have heard of 3 cases in the last 6 months in which chocolate cyst caused dysmenorrhœa in young women. Usually these cysts occur later in life.

DR. CULBERTSON: (closing): I hardly think we could explain the dysmenorrhœa on the basis of a hæmorrhagic ovarian cyst but it might very well result from such a development as adenomyoma in the pouch of Douglas. I might say that I removed all membranous material from the cul-de-sac as thoroughly as possible and resected the cystic portion of the right ovary, but removed nothing further,

the pelvic organs being in other respects normal. The appendix showed a mild chronic inflammatory reaction and was removed.

A NEW MANEUVER IN OCCIPITOPOSTERIOR POSITION

DR. D. A. HORNER: I want to call your attention to a maneuver we have developed of which we find no mention in the literature. It is the manual rotation of the occiput in posterior and transverse positions as a preliminary for the forceps operation. However, there are many notations of manual maneuvers and they consist of simply this: In a case of right occipitoposterior, use the hand which fits the occiput and rotate manually. In a right occipitoposterior the left hand would be used.

The maneuver which I am trying to bring out is one in which only the right hand is used in both right and left occipitoposterior positions. In the right occipitoposterior position the dorsum of the hand is applied to the anterior surface of the head with the thumb on the posterior parietal elevation in a clockwise direction. That leaves the hand ready for the introduction of a left-bladed forceps and keeps the head from rotating. In the left occipitoposterior the reverse would be used and the rotation would be counter-clockwise. It is sometimes necessary to raise the head out of the pelvis but the head must be in the perineum or in a similar plane. It can be raised completely out, and at the same time upward and downward pressure can be made on the occiput for the necessary flexion and diminishing of the persisting diameters; and it will be easy to bring the head into the pelvis if it is once down, and can be lifted off the perineum.

This maneuver is a great reducer of mortality in babies. We have used it in several hundred cases at the Lying-In Hospital. If this is of value to any one who tries it I would like to hear about it.

DISCUSSION

DR. C. E. PADDOCK: For years this has been my treatment of these cases, and I am glad that Dr. Horner is an advocate of the method. The frequency of these cases and the morbidity which follows the usual treatment seems to demand the use of a method such as this which has lessened the morbidity both in the fetus and the mother.

DR. DAVID A. HORNER (closing): In the German, French, English and Italian literature I have found not a single word about the use of the right hand in the correction of occipitoposterior position. I have found that the left hand is used in one case and the right one in the other. If Dr. Paddock has used it I am very glad to know it. I know others have used it but have not put it on record.

PSEUDOMYXOMATA PERITONEI

DR. EMIL RIES read a paper on pseudomyxomata peritonei (see p. —).

DISCUSSION

DR. E. W. FISCHMANN: I would like to ask Dr. Ries how soon after the rupture of one of these appendices or ovarian cysts may pseudomyxoma peritonei occur? About 2 years ago I saw a woman who had a multilocular pseudomucinous ovarian cyst with symptoms of an acute abdomen. A laparotomy was performed within a few hours after the onset of symptoms and the peritoneum was markedly injected and a small amount of mucus was found in the peritoneal cavity, due to the rupture of a small daughter cyst.

I also would like to ask about the firm adhesions that are described in the literature as accompanying this condition, and how frequently intestinal obstruction is caused by this?

DR. EMIL RIES (closing): I do not know how soon after the rupture of an ovarian cyst the patients develop the pseudomucinous condition, because in none of the cases was there any indication of the time of the rupture of the ovarian tumor. This apparently occurred by gradual stretching or giving way of the wall. Some of these patients die from more or less intestinal obstruction, and the prevention of adhesions has a large place in the treatment.

DR. CHARLES E. PADDOCK presented a paper entitled, "Acute Dilatation of the Stomach in Labor."

The chairman stated that he considered it eminently proper that a society devoted to the study of the biological sciences as well as to the art of healing, should note the passing of one who had contributed perhaps more than anyone else to its fundamental problems.

Jacques Loeb was born in Germany in 1859. He studied in Berlin, Munich, and Strassburg where he received the degree of Doctor of Medicine, taught in the Universities of Wurzburg and Strassburg, and later went to the Naples Zoological Station. In 1891 he came to America and taught in Bryn Mawr, University of Chicago, and University of California. From 1910 until his death he was in the Rockefeller Institute for Medical Research. He also worked in the Marine Biological Laboratory at Woods Hole and at Pacific Grove, California.

His work was on fundamental biological problems, especially those relating to the actions of living beings, the explanation of which he held to rest on a physiochemical basis. He sought a mechanistic explanation of the conduct of animals, eliminating purpose. He undertook to control the growth of living matter by physical or chemical means and used for this purpose all the resources of physical chemistry. In this field he made his epoch-making discoveries on artificial parthenogenesis, interesting in their bearing on the nature of fertilization. He became convinced that the behavior of colloids could be explained by the ordinary laws of chemistry the proof of which he presented last year to the Institute of Medicine of Chicago.

DELLA
CIRVGIA
DI GIOVANNI ANDREA
DALLA CROCE,
MEDICO VENETIANO,

Libri sette:

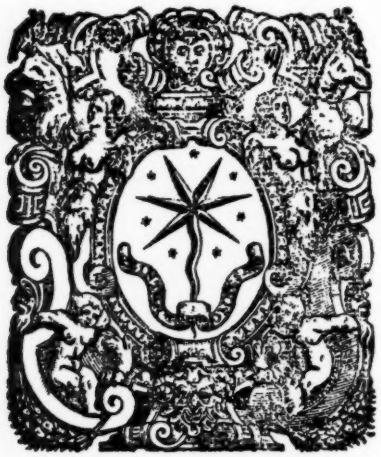
NE' QVALI SI CONTIENE LA THEORICA ET LA VERA PRATTICA, & si vedono à i suoi luoghi moltissime figure di Stromenti necessarij in questa professione:

Et finalmente con mirabile ordine si tratta tutto quello, che ad ottimo Cirugico nel curar' ogni sorte di ferite si conuiene.

NVOVAMENTE DATI IN LVCE.

Con vna copiosissima Tauola di tutte le cose più notabili.

CON PRIVILEGIO.



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THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

By ALFRED J. BROWN, M.D., F.A.C.S., Omaha, Nebraska

THE SURGERY OF GIOVANNI ANDREA DALLA CROCE

THE sixteenth century had marked the rise of surgery as apart from medicine and toward the latter part of this period it was looked upon practically as a specialized division of medical practice. The books which had been published contained much that was philosophical in nature and matters of surgical technique and nomenclature were loosely handled. The greater part of medical literature had its origin with either the Romans, Greeks, or Arabians and consequently the nomenclature consisted of a mixture of these different languages which had never been separated into its different parts and the various synonyms definitely established. The accomplishment of this task of carefully correlating the synonyms for the different surgical diseases was one of the achievements of Dalla Croce.

Of the man and his life but little is known. He was born in Venice but the exact date is lacking. In 1532 he is noted as a member of the College of Surgeons and about 1560 is spoken of as practicing surgery in Venice with great distinction. For a time he held an official medical position in the town of Feltre—the town whose name was given to an artist, Pietro Luzzo, who was the son of a surgeon and who originated the then modern grotesques which were so called because the subjects for these arabesques were taken from the decorations of ancient crypts or "grotte." For some reason, possibly because of a particularly joyless disposition, he was called Morto (dead) da Feltre. Dalla Croce died in 1575 shortly after the publication of his work which was issued in 1573.

The seven books of surgery by Joannes Andreas de Cruce was printed in Latin and published in Venice in 1573. The following year, 1574, an Italian translation was published from the press of Giordano Ziletti in Venice and is the volume reviewed here. Dalla Croce's work was considered at the time to be of sufficient importance to run through several editions and to be translated into German as well as Italian.

The work shows little advance along original lines and is rather a compilation of the work of previous authors arranged in an historical manner. Looking through it one is struck by the meticulous attention paid to surgical technique and particularly by the careful illustration of all operative instruments from the earliest times to the time of writing. As an example, the illustrations to the chapter on trephining show at first the coiled strap and bow string trephine and at the end the type of brace and bit which, save for the ornamentation, is practically identical with that in use today. With this factor in mind the volume might almost be classed as a work on operative surgery.

Dalla Croce, in the introduction, gives as his authorities the older writers from Hippocrates to Albucasis, and makes no claim to originality. He does not mention Brunschwig, Paré or any of the writers of approximately his own time. That he knew of their work, however, is shown by his teachings. His illustration of the withdrawal of an arrow is plainly a changed copy of Brunschwig's illustration of the same procedure. Likewise he illustrates Paré's forceps for removal of bullets and his tubes for drainage. In the text he refers to the facts emphasized by these contemporaries. For example, he calls attention to the importance, when searching for a foreign body, of placing the patient in the same position as he was in when he was wounded. This point was previously stressed by Paré as the result of his experience in the case of de Brissac.

The treatment of wounds advocated throughout the books is surprising for its modernity. In simple incised wounds Dalla Croce does not suture but draws the edges together by placing cloth on either side of the wound and lacing the cloths and not the wound. He illustrates five types of this form of dressing for larger or smaller wounds. The idea is similar to the one used during the World War for drawing wound edges together by placing adhesive strips along either side of the wound and lacing the strips together. For suture material he used various forms of needles and either silk or linen thread and of the two he prefers linen. In suturing he warns against dead spaces as likely to cause trouble. For drainage he advises cloth drains, and in some instances uses Paré's perforated tubes. He opens the thorax and advises that the drain be sutured to the skin so that it will not slip into the cavity and be lost.

The illustrations of surgical instruments are a noteworthy part of the volume and show in historical sequence practically all of the best known instruments up to the time. The various forms of arrows, spears, and darts in general use in war are also illustrated. This compilation of illustrations is the second great contribution which this author made to surgery.

REVIEWS OF NEW BOOKS IN SURGERY

AN unusual, happy and authoritative volume by three writers, Duval, a surgeon, Roux, an internist, and Béclère, a radiologist, has given us a clinical study of the duodenum[1]. The recent advancements in examination, diagnosis, and treatment of the various lesions of the duodenum are methodically investigated by this keen triumvirate.

The following points with their complications are discussed: The duodenum in combination with gall stones; essential stenosing periduodenitis; chronic compression of the third portion of the duodenum by the mesenteric pedicle; duodeno-jejunostomy; radiologic signs of ulcer of the duodenal bulb; and intoxication in duodenal retention.

Well selected and convincing roentgenograms illustrate the text, and the reviewer feels that every internist and surgeon dealing with duodenal lesions should study this work. KELLOGG SPEED, M.D.

THERE is no operation in neurologic surgery more gratifying to the patient and satisfying to the surgeon than section of the sensory root of the fifth cranial nerve for major trigeminal neuralgia. In Hartmann's monograph[2] we find a collection and review of the literature, mainly American, upon the treatment of trigeminal neuralgia in addition to the author's personal observations upon 65 cases which were operated upon by various French surgeons. One cannot help but feel the comparison between the progress and development of neurologic surgery in this country and upon the continent, after reading this volume.

The major part of the subject matter concerns the occurrence of keratitis following division of the sensory root. This is a postoperative complication which has interested American neurologic surgeons for many years. Keratitis which follows section of the sensory root may be divided into:

1. That due to a direct lesion of the ganglion,
2. That which may be attributed to palpebral mal-occlusion,
3. That produced by trauma to an anæsthetic cornea,
4. That which occurs in the absence of any of the preceding factors and which presents the characteristics of an actual trophic lesion.

To grasp the significance of Hartmann's theoretical explanation of the pathogenesis of such a keratitis, it is necessary to keep in mind the physiological results which have been observed to follow the operation. It is interesting to note that the author has confirmed the preservation of deep sensibility in the face after section of the trigeminal nerve and that he accepts the facial nerve as the afferent pathway for those fibers which carry that sensation. In addition, attention is called to the abolition of the corneal and oculo-cardiac reflexes; exaggeration of the vasomotor reactions upon cutaneous stimulation; increased reaction of the pupil to different alcaloidal drugs and exaggeration of the sweating reaction after the injection of pilocarpine. The last three phenomena are believed to be evidence of an increased excitability of the nerve terminations of the "organo-vegetative" system. It is predicated that an increase in the tone of the "organo-vegetative" or parasympathetic system predisposes to a decrease in the local defensive resistance of the tissues. In other words there is believed to be a liberation of the peripheral parasympathetic system by an interruption of the cerebrospinal sensory pathway. Myosis, enophthalmus, narrowing of the palpebral fissure, decrease in intra-ocular tension and cutaneous vasodilatation are not looked upon as evidence of paralysis of the sympathetic fibers but as the phenomena resulting from irritation of the parasympathetic nerve endings and therefore elevation of parasympathetic tonus. This predisposing etiological factor plus any of the direct causes previously mentioned contributes to the pathogenesis of the keratitis.

It should be pointed out that the postoperative occurrence of keratitis cited by Hartmann is much higher than that found in any series of cases presented by the neurologic surgeons of this country. Further, the frequency of this complication has been reduced by a careful improvement in operative technique. It has always seemed striking that in experimental animals, in which the sympathetic fibers to the eye are closely related to the ganglion in its entirety, keratitis is an almost constant postoperative result. In man, it is well known that the sympathetic fibers to the eye are closely related to the ophthalmic division and the medial aspect of the ganglion. It is a fact that by not disturbing the ganglion from its bed and by avoiding the medial side and the ophthalmic division, the occurrence of keratitis has been materially reduced. To say that keratitis is produced by parasympathetic stimulation rather than sympathetic paralysis seems to be engaging in a rather futile search for an explanation. The careful study of the results of cervical sympathectomy may throw some interesting sidelights upon the question and it would not be surprising to find in the pathology of the sympathetic system the explanation for many of the bizarre facial pains so closely resembling major neuralgia as well as the occurrence of a keratitis. It should not be inferred that postoperative keratitis occurs so frequently as to offer a contraindication to the relief of trigeminal neuralgia by section of the sensory root.

[1] ÉTUDES MÉDICO-RADIO-CHIRURGICALES SUR LE DUODENUM. By Pierre Duval, Jean-Charles Roux, and Henri Béclère. Paris: Masson et Cie, 1924.

[2] LA NEUROTOMIE RETRO-GASSERIENNE—SES CONSEQUENCES PHYSIOLOGIQUES ET PATHOLOGIQUES—CONTRIBUTION A L'ETUDE DE LA KERATITIS NEURO-PARALYTIQUE. By Edward Hartmann. Paris: Gaston Doin, Éditeur, 1924.

The remainder of the subject matter brings under one cover the mass of literature, exclusive of surgical technique, concerning major trigeminal neuralgia. The small volume is indeed worth while.

LOYAL E. DAVIS.

THE surgery of the sympathetic nervous system has recently received a great impetus. However, it seems prone to be carried farther than our present knowledge of the physiology and anatomy of this portion of the nervous system might justify. Unfortunately, the tendency rather empirically to remove or interrupt portions of the sympathetic system is quite apt to bring discredit to a surgical therapeutic principle which may have very definite and limited indications.

So it is with a feeling of regret that we see in Jonnesco's new work[1] beautiful plates illustrating the gross anatomy of the cervical sympathetic system unaccompanied by a complete discussion of physiological facts or theories which might establish a firm foundation for this new field of surgery. When confronted at the operating table with the actual structures we realize how diagramatic such illustrations may be.

There are few facts in surgical therapeusis which have withstood rigid tests which are not founded on firm physiological and anatomical principles capable of being demonstrated experimentally. It is a banality to state that there is no short cut to proving indications for surgical therapy. So, it seems better to view with healthy skepticism the attempts to cure glaucoma, hyperthyroidism, epilepsy, angina pectoris, facial neuralgia, and migraine by interrupting the cervical sympathetic trunk. Particularly is this so when the experimental evidence is so sadly lacking to point the way.

It is a safe conjecture to say that those operations upon the sympathetic system which now exist for a score of maladies will eventually be reduced to a modest number and it is safe to say, further, that such indications will rest upon rather strong corroborative experimental evidence.

LOYAL E. DAVIS.

[1] LE SYMPATHIQUE CERVICO-THORACIQUE. By Prof. Thomas Jonnesco. Paris: Masson et Cie., 1923.

AMERICAN COLLEGE OF SURGEONS

REPORT OF HOSPITAL STANDARDIZATION FOR THE YEAR 1924 UP TO OCTOBER 1

Including List of Approved Hospitals of Thirty-five or More Beds in the United States and Canada

THE American College of Surgeons has completed the seventh annual survey of hospitals in the United States and Canada. The list of approved hospitals published herewith shows the result of: (1) the seventh survey of hospitals of one hundred beds and over; (2) the third survey of hospitals of fifty to one hundred beds; (3) the preliminary survey of (a) hospitals of thirty-five to fifty beds, (b) National Homes for Disabled Volunteer Soldiers, (c) Marine Hospitals of the United States Public Health Service.

During the year twenty-one hospitals in New Zealand, Australia, and Hawaii were visited, but as the survey has not yet been finished the list as published in this report is incomplete. It is expected that the survey of these hospitals will be completed before the first of the year, and the list of hospitals published in the January *Bulletin*.

PROGRESS OF HOSPITAL STANDARDIZATION

Hospital standardization, a movement for hospital betterment, though carried on actively for only 7 years has made splendid progress as shown by the following statistics.

1924

A. Approved hospitals of 100 beds and over—
   Number of hospitals surveyed 961
   Number of hospitals approved 831
   Percentage 86.5

B. Approved hospitals of 50–100 beds—
   Number of hospitals surveyed 973
   Number of hospitals approved 508
   Percentage 52.2

C. Approved hospitals of 35–50 beds—
   Number of hospitals surveyed 307
   Number of hospitals approved 49
   Percentage 15.9

D. Summary for 1924—
   Total number of hospitals surveyed ... 2366
   Total number of hospitals approved ... 1416
   Average percentage for the United States and Canada (50 beds and over) 69.3

E. Summary—

(1) Seven surveys of hospitals 100 beds and over:

Year	*Hospitals surveyed*	*Hospitals approved*	*Percentage*
1918	692	89	12.9
1919	692	198	28.6
1920	692	407	58.8
1921	761	573	75.3
1922	812	677	83.4
1923	870	751	86.2
1924	961	831	86.5

(2) Three surveys of hospitals 50–100 beds:

1922	812	335	41.3
1923	916	430	46.9
1924	973	508	52.2

The hospital program of the American College of Surgeons as expressed in the minimum standard has developed rapidly and taken firm root in the hearts and minds of the people of America. There is an increasing demand for it from all quarters. The movement has become its own propagandist, for it has proved its worth. The program is definite, its requirements reasonable, its methods of presentation acceptable. The requirements are universally recognized for they aim at focusing the hospital's attention directly on the patient. This surely means much to the 12,000,000 patients passing through the hospitals of the United States and Canada annually.

INCREASING INTEREST AND CO-OPERATION IN HOSPITAL STANDARDIZATION

Hospital standardization, in its few years of existence, has accomplished much for better hospital service. This is due in no small part to the keen interest and co-operation manifested, not only on the part of the hospitals themselves, but also of the medical and nursing professions, the public and the numerous allied organizations in the field, national, state, provincial, and local.

During the year the utmost co-operation and assistance has been forthcoming from the Council

on Medical Education and Hospitals, the American College of Physicians, the American Society of Clinical Pathologists, the various radiological associations, the American, the Catholic, the Protestant, and the Methodist Hospital Associations, the Central Council on Nursing Education, and other national, state, provincial and local, allied associations as well as numerous governmental departments.

This year requests to include their respective groups of hospitals in the survey were received from the Board of National Homes for Disabled Volunteer Soldiers, the United States Public Health Service, and the United States Veterans Bureau. All this work has been completed excepting that of the Veterans Bureau Hospitals which work has been commenced but will not be finished till the first of the year.

It is only through whole-hearted interest and co-operation of this kind that much can be accomplished by the College, while on the other hand the College is anxious to co-operate with the various groups mentioned and be of any service it can to them.

AIMS AND OBJECTS OF HOSPITAL STANDARDIZATION

The objects of the hospital standardization movement are definite and practical. They may be summarized as follows:

(1) To focus all the activities of the hospital on the patient. We recognize today that the patient is the most important person in the hospital and all activities should be carried on with this always borne in mind. Every person in the hospital organization, regardless of what he does, has a unit of service to contribute toward the patient's welfare. Hospital service is composite in nature—all focusing on the patient. (2) To provide in hospitals adequate and efficient organization, personnel, facilities and procedure so as to insure for the patient (a) an early, accurate, comprehensive diagnosis, (b) the most rational and scientific treatment, (c) the rapid return of the patient to normal physical health if at all possible. It is the responsibility of every hospital to provide this for each patient treated therein. It is the minimum the patient is entitled to. (3) To promote better co-operation in and among the three groups directly connected with the hospital, namely, the board of trustees or governing body, the medical staff, and the hospital staff or personnel. These three bodies must work well together in the performance of their common task—caring for the patient. Within each group harmonious co-operation is very essential for success. (4) To promote better co-ordination throughout the institution. Analysis of hospital service shows clearly that it is made up of a number of distinct units differing in character, but interrelated and interdependent to a very marked degree. These units must be well co-ordinated in order to secure the best final results. Hospital standardization is bringing this co-ordination about. (5) To stimulate more interest in clinical work. Through the periodic staff conferences for analysis of the professional work of the hospital, through good records, and available, adequate diagnostic and therapeutic facilities, it is only reasonable to expect that more interest will be aroused in the clinical work—especially in a closer study of end-results. (6) To educate the public as to the right kind of hospital service. The hospitalization of the sick is a big problem today. On the average one out of ten persons in the United States and Canada goes into hospitals for treatment annually—last year almost twelve million people went through these hospitals; the outlay for maintenance was approximately one billion dollars. When we realize this, is it not essential that the public be intelligently informed as to hospitals and the service they not only wish to give but are responsible for giving in the right way?

The minimum standard so well known to you all grew out of clear thinking minds with vision and proper perspective in search of ways and means to improve surgery. The founders of the movement discovered a need for improvement in hospital service and established a practical remedy in the minimum standard requirements—a measure of professional efficiency and service to the patient. Though this standard is minimum in name, a proper interpretation shows that it is maximum in effect and application, for it has a beneficial influence on all the service throughout the institution, the aggregate effect of which is reflected ultimately in the care of the patient and results obtained.

Finally, it may be justly claimed for this program that when conscientiously applied at least four important benefits will accrue therefrom. These are: (1) the shortening of the number of days the patient stays in the hospital; (2) the elimination of incompetent and unnecessary surgery; (3) the reduction of infections and complications, and (4) the lowering of the hospital death rate.

Any hospital can accomplish these if imbued with the proper spirit and interest in this movement. It is the serious responsibility of all hospitals to give careful attention to the above four suggestions.

THE PRESENTATION OF THE HOSPITAL STANDARDIZATION PROGRAM TO THE FIELD

The program of hospital standardization is presented through personal visits from a group of carefully selected hospital visitors or surveyors, graduates of Class A medical schools, with hospital experience and executive ability. These representatives are thoroughly familiar with the application of the requirements of hospital standardization. They survey the institution according to a well outlined procedure and record their findings on a prescribed form for that purpose, thus making all inspections uniform. This report is sent immediately to headquarters and with other data is fully considered. It must be remembered that the visitor is not there to pass judgment on the hospital but to *find the facts* in an impartial, unprejudiced manner, and report same to headquarters, and there it is determined whether or not the hospital meets the minimum standard. The personal visits and the impartial manner in making the report appeals to the hospital as an unprejudiced effort to arrive at facts. A follow-up service is then instituted and all the assistance necessary rendered from headquarters to eliminate deficiencies in hospital service.

Hospital Standardization Explained

STAFF ORGANIZATION

Efficient staff organization is essential for the professional success of any hospital. Such an organization sets forth definite requirements for membership and should be based on the following principles or considerations:

The staff of the hospital as interpreted in the minimum standard requirements laid down by the American College of Surgeons includes all doctors privileged to practice in that institution, whether or not already organized into other groups such as "consulting staff," "appointed staff," "courtesy staff," or others.

The board of trustees guards carefully the granting of privileges to practice in the hospital. This is extended only to those who are (a) full graduates in medicine, in good standing, and legally licensed to practice in that particular state or province, (b) who are competent in their respective fields of activity, and (c) who are ethical in business and practicing methods. Non-medical practitioners have no place in an approved hospital. Likewise any doctor practicing methods regarded generally by the profession as unethical, unsound, unscientific, or commercial, is debarred from use of the hospital facilities.

The board of trustees and staff go definitely on record against the practice of fee-splitting by the unanimous adoption and enforcement of the anti-fee-splitting resolution. In this connection it is recommended that the resolution, or the rules and regulations embodying it, be signed individually by the doctors having the privileges of the hospital.

The staff formulates rules and regulations setting forth the organization and procedure for the guidance of the professional work of the hospital. These are then approved by the board and finally adopted by the staff, and the individual members thereof affix their names to them as an evidence of good faith that they will abide by these requirements.

A staff requires certain officers and committees in order to function. It is advisable that there be a chairman and a secretary, both having leadership and initiative, and a few working committees such as: an executive committee to look after the business and administrative affairs coming before the staff; and standing and special committees to take up the work as necessary—the former carrying on during the entire year and the latter for the time required to accomplish the special work assigned.

It is of the greatest importance that the staff, which includes all physicians privileged to practice in the hospital, meet in conference regularly at least once a month at a specified time and place, preferably in the hospital. The staff conference is the main objective of organization.

The agenda for the staff meeting provides a thorough review of the hospital service during the period under consideration and as outlined in the monthly analysis sheet submitted. The discussion is analytical in type and includes all the data concerning the volume and quality of work carried on. The major attention is directed to the latter or the quality of work and this is brought out in a free and open discussion of agreement and disagreement of diagnoses, frequency of consultations, infections, unimproved, deaths and anything else closely related to the clinical work. It should consist of a complete medical audit. The discussion is always impersonal and the criticism constructive in nature. The meeting is characterized by a spirit of unselfishness, each member being willing and anxious to give of his experience for the benefit of others and to receive from them for his own. Each physician permitted to practice in the hospital shows his loyalty to the institution in fulfilling his duty as a staff member by supporting a clear, straightforward analysis of the clinical assets and liabilities.

The staff conference is, in other words, the periodic medical audit which each hospital must have. It is important to have a well-arranged and interesting agenda for this conference. This agenda usually includes: (a) a discussion of business and administrative matters pertaining to the professional work of the hospital, which embodies, after the roll call of members and the reading and disposal of minutes of previous meetings, the reports of various committees, and new business. Too much time cannot be taken up with this phase. It is recommended that the business and administrative details as referred to above be dealt with at a previous meeting of the staff or executive committee. (b) A discussion of the clinical work of the hospital, having for its main objective a thorough analysis or audit for the period under review as follows: (1) The presentation of a report of the work of the hospital for the month, on blackboard or through the distribution of the monthly analysis sheets properly filled out; (2) the discussion of patients discharged since the last review period with special reference to infections, deaths, or unimproved; (3) the discussion of the condition of patients in the hospital, such as complications, unusual conditions, or intricate diagnoses; (c) the presentation and discussion of reports on case records and diagnostic and therapeutic departments as, the clinical laboratory, X-ray, etc.; (d) the considerations and recommendations for the improving of the professional service in the hospital. A record is kept of all the proceedings of each meeting and these are available for the hospital representative when making his survey.

CASE RECORDS

It has been well said, "A hospital without records is like a clock without hands, still running but giving out no information as to whether it is right or wrong." Case records are as necessary to a hospital as water is to a river. Every hospital, without exception, must have them.

It is primarily essential that in each hospital there is a definite determination on the part of the medical staff, the hospital staff and the board of trustees that good records are essential and must be secured on every case that passes through the institution. Records after a routine fashion are useless. They must be the outcome of sincere and interested effort. *An efficient record system in a hospital presupposes:* (a) A well organized and arranged department, having adequate space and equipment, such as desks, filing cabinets, typewriter and supplies, including the forms to be used. In respect to the latter there are several types in use. Some hospitals use the ordinary blank forms while others prefer the semi-stereo or semi-diagrammatic type. The American College of Surgeons submits samples upon your request. However, the form used is of little account as compared with that which is really on it. The medical staff in co-operation with the superintendent decides on the type of form used in that particular hospital.

(b) A personnel for the department such as a record clerk or librarian with the assistants necessary for carrying on and developing the system. When such is not possible the responsibility is placed on some member of the hospital staff having a knowledge of this particular work and who will see that the system works smoothly.

(c) A definite method for securing histories of patients. This appears to be a difficult task in some hospitals. There are five methods found in use. These are: (1) the taking of the history by the doctor himself; (2) the dictating of the history by the doctor to a clerk who transcribes it into typewritten form; (3) the use of the dictaphone by the doctor; (4) the taking of the history by the interne who writes it up; (5) a combination of methods by which the history is secured through some means other than by the doctor who adds the physical findings and technical information. A quiet, convenient place on the ward with the necessary supplies readily available will assist materially in the producing of records.

(d) A proper supervision of all the records. This is important in order that good quality may be assured. There should be a triple supervision exercised in every hospital as follows: (1) The doctor in charge of the patient should be responsible for seeing that a history of good quality is promptly produced and when completed should affix his signature thereto; (2) the record clerk or librarian should be held responsible for seeing that all the parts of the record and findings are assembled into the patient's permanent file; (3) the efficiency or record committee of the staff in most hospitals should go over all the histories at regular intervals for the purpose of appraising them. Sometimes this function is assigned to a duly appointed medical registrar.

(e) A complete record of component parts. The record, being a clear logical story of the patient with all the data about the illness, the treatment and the after results, must, therefore, be composed of logical units contributed usually through many sources. These component parts are:

1. *Identification data*—giving name of hospital; name, address and case number of the

patient; color, age, occupation, nationality, religion; dates of admission, operation, and discharge.

2. *Complaint*—the patient's statement of reasons (signs and symptoms) for seeking medical aid.
3. *Present illness*—an orderly story of the onset and course of the disease, beginning with date, mode of onset and probable cause, and continuing with description of signs and symptoms of the disease or injury up to the present time.
4. *Past history*—a summary of the patient's life in its relation to pathology, illnesses with or without complications, operations or accidents; habits, social conditions or any data which may be related to the present condition.
5. *Family history*—such data as related to present illness; investigation of evidence of hereditary or infectious diseases.
6. *Physical examination* (not opinions but facts)—a complete detailed description by regions or systems, of the doctor's actual findings as a result of a thorough examination of the patient.
7. *Special examinations*—consultations, reports of clinical laboratory, X-ray examinations, and other findings.
8. *Provisional diagnosis* (and indications for treatment)—a statement of the most plausible pathological condition to be recorded after completion of history and physical examination.
9. *Treatment, medical or surgical*—includes a record of all orders for medicine, treatments, and diets. If operated on the preoperative diagnosis should be written before the operation begins. Give a full description of operative procedure and findings, normal and abnormal, and of all organs explored.
10. *Pathologist's report*—a full description, gross and microscopic, of tissues removed.
11. *Final diagnosis*—to be recorded when determined. Secondary and associated diagnoses should be recorded in the order of their importance.
12. *Progress notes*—an orderly story of the course of the disease, consisting of notes made each day for serious cases, of new signs and symptoms, complications, consultations, removal of drains, splints and stitches, development of infection in a clean wound, its cause and character, and all other data affecting the course of the disease.
13. *Condition on discharge*—a specific statement as to patient's condition in relation to normal health with positive or negative evidence of persistence of any symptoms pertaining to illness, carrying with it information providing a prognosis and indications as to fitness of the patient to return to active or working capacity.
14. *Follow-up records*—concise notes made at subsequent visits of the patient or from subsequent reports as to condition of patient, to determine end-results of treatment and appraise the work of the institution.
15. *Autopsies*—in case of death and postmortem examination, a full description of autopsy findings.

Filing of records. Every hospital should have a good filing system. Records being kept for many purposes must be well preserved and filed in a readily accessible manner for reference.

There are various methods used for filing records in hospitals today. Preference, however, is given to the envelop and vertical or folder systems, which are believed to be more practical and convenient. Each envelop or folder contains the complete data regarding the patient's illness and should have on the outside, in a readily visible location, the necessary data for identification, such as the patient's name and number at least. In many instances more detailed data is found and this also is commendable.

All records should be properly indexed. This presupposes a well-arranged record department under competent supervision of a record librarian or some person to whom this duty has been delegated who should have a working knowledge of the fundamentals of an efficient filing system.

A practical filing system includes the following:

a. Index for identification of patients whereby the record can be found at least by name or number. This may be further elaborated into indices for date of admission, date of discharge, service, or other divisions. However, the former two as mentioned above, the patient's name and number, supply the essential information for ready and accurate identification.

b. Index of diseases or diagnoses according to a classification by systems affected or anatomical or regional divisions. Several nomenclatures are available, namely, Standard, Massachusetts General, Bellevue, Dewey, Post, and many others. Many hospitals build up their own nomenclature.

c. Indices for (1) associated diseases or diagnoses; (2) secondary conditions or complications; (3) operations; (4) causes of death.

d. A monthly analytical summary of the work according to the analysis sheet, as suggested by the American College of Surgeons, showing volume of work done in all departments and results obtained.

It is advisable that in developing a filing system of this kind a hospital start out in as simple a manner as possible, gradually developing the system to cover the range of amplification indicated.

Follow-up. It is recommended that each hospital institute and develop a follow-up system of some kind for their patients. Through such means only can we properly appraise the work of the institution and determine intelligently the end-results of treatment. Hospitals are showing more interest in this matter at present.

Progress record. Hospitals generally must pay more attention to the progress records of their patients. This consists of a logically arranged story of the course of the disease, including notes made each day for serious cases and a record of new signs or symptoms, complications, consultations, removal of drains, splints or stitches, and of the development of infection in a clean wound, with its cause and characteristics. The development of complications should be descriptive of physical findings and all procedures used in making the diagnosis, and treatment rendered.

Condition on discharge. It is important that the condition on discharge of all patients be fully described. This cannot be properly done by using a mere word such as "cured" or "well," "improved," "unimproved," or "died." There must be a specific statement as to the patient's condition in relation to normal health, with positive or negative evidence of the persistence of any symptoms pertaining to the illness. The condition on discharge should carry with it information providing a prognosis and indications as to the fitness of the person concerned in relation to working or active capacity.

CLINICAL LABORATORY

Every modern hospital has a well-equipped and organized clinical laboratory with adequate space, properly lighted and ventilated and conveniently located to the professional services of the hospital. Such a department provides at least the following services: chemical, bacteriological, serological, and pathological. It is essential that all tissues removed at operation be examined pathologically and the gross and microscopic findings carefully recorded.

Occasionally these clinical laboratory services have to be secured from outside, and under such conditions they must be readily accessible so that too much time is not lost in giving the patient the advantages of them. It is necessary to have the laboratory under competent supervision in order to be efficient. This is best done through the medium of a clinical pathologist, but where such cannot be obtained the supervision may be carried on by a member of the medical staff having knowledge of this work. Trained technicians under competent supervision render most favorable service. Records of all work done are kept in duplicate, one copy filed in the department and the other sent up to the ward to become a part of the patient's history.

There are several ways in which hospitals finance laboratory service: (a) they charge in accordance with a regular schedule of prices at so much per test; (b) they include laboratory service in the per diem rate charged to the patient; (c) they charge a flat rate to include all the laboratory work; (d) they allow a free service such as might be granted by a federal, state, county, or endowed laboratory; (e) they permit the pathologist to collect the entire fee and he in return gives to the hospital a complete service.

However, the system used must not limit or embarrass the amount of work called for or required in the best interests of the patient.

While hospital standardization emphasizes the importance of a well organized and equipped department as mentioned above, yet the primary consideration is *the necessary volume of efficient work being done for the patient.*

X-RAY DEPARTMENT

Like the clinical laboratory, the X-ray department is also essential in every hospital. It should have the necessary space, be properly lighted and ventilated and conveniently located in the professional services. It should be organized and equipped to do radiographic and fluoroscopic work at least. Superficial and deep therapy is advisable where possible and practical. A portable unit added to the equipment is of great value for cases that are not conveniently and safely transportable from the ward to the department. Supervision through a medical roentgenologist is essential not only from the standpoint of administration and the carrying on of complicated technique, but particularly on account of the interpretation of findings which can only be properly done by such a trained person. Records of all examinations are made in duplicate, one copy being kept in the department, the other sent to the patient's file on the ward as part of the history. The films or plates are filed in a systematic manner so as to be readily accessible when required.

Hospital Standardization and the Small Hospital

The work of the College during the past 7 years has revealed an urgent need for extending the survey to the next group of hospitals, namely, those from twenty-five to fifty beds in size. In the beginning of the year there were three thousand, three hundred and twenty-two active general hospitals in the United States and Canada of twenty-five beds and over, registered with the College for survey. Of this number 861, or twenty-six per cent, with a bed capacity of 179,507, were one hundred beds and over; 922, or twenty-seven per cent, with a bed capacity of 59,079, were fifty to one hundred beds; and 1,529, or forty-seven per cent, with a bed capacity of 48,727, were twenty-five to fifty beds. Thus, forty-seven per cent, or almost half the number of hospitals in the United States and Canada, are in the twenty-five to fifty bed class.

It is interesting to note the distribution of these hospitals in relation to population. We find that approximately twenty-two per cent are in cities of 100,000 or over; six per cent in cities of 50,000 to 100,000; eight per cent in cities of 25,000 to 50,000; fifteen per cent in cities of 10,000 to 25,000, and forty-nine per cent in rural communities under 10,000. This, however, does not mean that all hospitals of twenty-five to fifty beds are found in areas of 10,000 population or less, but it is a fact that a large percentage of them are to be found in such communities.

The College is firmly of the opinion that there is a real work to do for this group of hospitals—twenty-five to fifty beds. Many reasons can be put forth for this.

There has been an ever increasing demand, not only from the hospitals themselves, but also from the public, for the College to extend the hospital betterment movement and service to the group of institutions of twenty-five to fifty beds, as over fifty per cent of the people, it is stated, live in the rural communities and the larger percentage of these institutions are found there. It is reasonable to claim that these hospitals serve a most worthy group who are entitled to efficient hospital service.

Hospitals in this class have more professional difficulties proportionately than the larger ones. Not only are there deficiencies in professional service due in some cases to lack of first hand knowledge, but occasionally there exist jealousies among the profession which tends to diminish good co-operation, consultations, etc. Under these circumstances the College has already been of constructive assistance.

In many instances we find the dishonest, unethical fee-splitting doctors driven from the larger, well regulated approved hospital and carrying on in the smaller institution unchecked and uncontrolled in his professional work. The only remedy for this condition is to have these institutions standardized also, in order that such doctors can be eliminated or properly controlled. There is a very apparent need for this today.

It is well known from our daily experience that there are many emergency or acute surgical cases which are not safely transportable. There is, therefore, a very urgent need to have these smaller hospitals adequately organized and equipped to deal with such cases. Many hospitals of twenty-five to fifty beds lack scientific facilities and are having financial difficulties. The College can frequently help solve this problem by bringing about better team-work and co-operation between the larger and smaller institutions or between the hospital and the state or province in services such as X-ray and Clinical Laboratory. Grouping of these services can be done at a great financial economy. The problem for each institution, however, must be worked out on its own merits. This can best be done by the College representative through his personal visit.

Thus the College, through a service of this kind, can be a factor in making available better hospital service for the mass of people. To this end the College has, this year, made a preliminary survey of all the hospitals of thirty-five to fifty beds in the United States and Canada, a list of the approved appearing in this report.

Hospital Standardization and the Future

From the experiences of the past seven years the College finds it advisable and necessary to visit the hospitals annually in order to insure the best and most permanent results. The personal visit of the representative each year does much to keep the hospitals up to the standard as well as affording an opportunity for constructive aid in solving many of the more intricate professional problems that arise from time to time. To this end the College has endeavored to visit all the hospitals of fifty beds or over again this year.

The College further realizes that no survey can be carried on successfully without giving concurrently an extensive background or supporting service. Accordingly the Hospital Information and Service Department has been organized during the early part of the year. The work of this new department has grown rapidly and in the

first ten months of its operation served 1,042 institutions seeking information and assistance in the solving of their problems and increasing the efficiency of the institution. This service is rendered through carefully edited letters or articles of information compiled at headquarters, through abstracted authoritative information and package libraries sent out on loan. The department has been able to give the field a much quicker service than formerly. On very urgent occasions a preliminary wire giving data in abstract may precede the package library in order to expedite matters. The service is free to any hospital upon request.

There have been ever-increasing demands of various kinds made on the College during the year, which have been met so far as it was physically and financially possible. The attendance and interest at the Hospital Conference of each Sectional Meeting has greatly increased and early in the series of meetings it was found necessary to extend the program to the second day. A large number of round-table conferences have thus been held, affording all the hospital people an opportunity to informally discuss their problems.

In giving serious thought to the present and future development of the hospital standardization program the College feels that the time has now arrived when greater thought must be directed to (1) the giving of more attention by the hospitals to follow-up and end-results, (2) the developing of minimum standards for the various clinical services and departments in hospitals. This year the College has emphasized these two matters particularly, in the numerous Sectional Meetings held in the United States and Canada, and will continue to stimulate more interest in them.

It is most gratifying to note that greater attention is being paid to "follow-up and end-results" in hospitals today. This is the only way in which we can make a real appraisal of the work and properly compare statistics. No institution can be conducted in a comprehensive manner without close follow-up of all patients discharged and periodic interpretation of end-results.

The hospitals today are looking for standards and especially such as are minimum and practical. Valuable service can be rendered by the College in submitting carefully worked out minimum standards. It is the earnest desire of the College in this work that the institutions standardized will not be satisfied with merely meeting the minimum but will go on ever increasing in efficiency until the maximum is reached.

During the past year a minimum standard for fracture service in hospitals was established. This standard was submitted by the Fracture Committee of the American College of Surgeons after extensive investigation and subsequent study of data received through carefully selected regional sub-committees in all parts of the United States and Canada. This standard has been very well received throughout the field. The following are the recommendations by the Committee.

A. That all general hospitals be equipped to care for fractures; that the minimum equipment for the transportation and emergency treatment of fractures be the following or its equivalent:
   1. Thomas upper extremity splints
   2. Thomas lower extremity splints with traction straps, slings and buckle straps
   3. Hodgen splints
   4. Coaptation splints, assorted sizes
   5. Cabot wire splints
   6. Straight pieces of wood (of assorted length, width and thickness) for splints
   7. Plaster of Paris bandages
   8. Some form of overhead frame for suspension
   9. Suitable X-ray apparatus, including a portable machine, if practicable.

B. That it is highly desirable that one individual surgeon be responsible for the supervision of the care of fractures in each hospital service.

C. That special record sheets be used for fractures.

More recently a minimum standard for history taking has been recommended by the Committee of the College on History Review, an outline of which is to be seen in the text of this report under the heading of Case Records.

The College has attempted in its program, and will attempt in the future, to stimulate more interest in the organization and administration of clinical departments in hospitals. The programs of the Sectional and General meetings include interesting papers and discussions on the essentials for the organization and administration of such special departments as surgery, medicine, ophthalmology, oto-laryngology, obstetrics and other services. It is hoped that minimum standards may in time be established for these as a guide in hospital service and development.

ANALYSIS OF HOSPITAL SERVICE

For Month Ending

DISCHARGED

Cured	48
Improved	117
Relieved	0
Unimproved	8
To return for secondary operation	2
Admitted for diagnosis only	1
Deaths within 48 hours	2
Deaths institutional	8
Released	0
Labor	42
Newborn	43
Total discharged	271

DIAGNOSES

Provisional and final agree	162
Provisional and final disagree	17
Discharged with additional diagnosis	0
Discharged with no diagnosis made	8
Labor	42
Newborn	42
Total discharged	271

INFECTIONS

Institutional		On Admission	
Medical	0	Medical	0
Surgical	5	Surgical	12
Obstetrical	0	Obstetrical	0
Total infections	5	Total infections	12

CONSULTATIONS

Asked and obtained	24
Asked, not obtained	0
Indicated, not asked	0

DEATHS

Medical	3
Surgical	2
Obstetrical	0
Newborn	4
Stillborn	2
Total deaths	11

AUTOPSIES

Medical	0
Surgical	0
Obstetrical	0
Newborn	1
Stillborn	0
Total autopsies	1

CAUSES OF DEATH

Retrocæcal abscess	1
Endocarditis, malignant	1
Illuminating gas poisoning	1
Peritonitis, tuberculous	1
Umbilical hæmorrhage, newborn	1
Stillborn	2
Premature birth	1
Infective jaundice infant	1
Strangulated femoral hernia	1
Cerebral hæmorrhage, traumatic	1
Total deaths	11

UNIMPROVED

Operation advised	1
Suspected carcinoma stomach	1
To return for operation	1
Hypertrophied tonsils, no operation	1
Hyperthyroidism and myocarditis	1
Tuberculous peritonitis, pulmonary tuberculosis	1
Brachial paralysis	1
Fractured ulna—to return for further treatment	1
Total unimproved	8

CASE HISTORY DEFICIENCIES

Case Number	Identification data	Complaint	Personal history	Family history	History of present illness	Physical examination	Special reports	Consultations	Clinical laboratory	X-ray	Other	Provisional diagnosis	Medical or surgical treatment	Pathological findings	Gross	Microscopic	Progress notes	Final diagnosis	Condition on discharge	Follow-up	Autopsies
4965				√								√				√				√	
4969					√	√											√				
4970			√					√					√							√	
4973																	√				
4974			√			√		√								√					
4979		√		√						√							√			√	
4981					√				√												
4986			√			√		√									√				
4989										√										√	
4990				√			√							√					√		
4995														√			√				
4999				√								√								√	
5000		√								√						√					
5002				√					√									√			
5004			√					√								√					
5010			√			√							√								
5011				√						√				√						√	
5013								√		√											
5017						√							√				√				
5019		√							√						√						
5025				√										√							
5027			√									√									
5028					√														√		
5029										√											
5030			√								√									√	
Total		3	7	7	3	5	1	5	3	3	4	3	3	4	1	4	6	1	2	7	

LABORATORY REPORT

Urinalysis	
Routine	276
Functional	12
Quantitative	28
Cultures	11
Blood Examinations	
R.B.C.	121
W.B.C.	182
Differential	60
Hæmoglobin	139
Coagulation time	122
Typing	6
Wassermann	47
Widals	12
Cultures	14
Blood chemistry	
Blood sugar	16
Blood urea	17
Non-protein nitrogen	14
Creatinine	11
Uric acid	14
Others	0
Tissues	
Gross	47
Microscopic	47
Spinal Fluid	
Cell counts	8
Colloidal gold	9
Cultures	6
Globulin	7
Wassermann	9
Gastric analysis	10
Stool examinations	8
Smears	13
Animal inoculations	4
Sputum examinations	23
Vaccines	8
Exudates	5
Transudates	7
Throat cultures	21
Basal metabolism	11
Autopsies	6
Miscellaneous	0
Total	1351

REPORT OF X-RAY DEPARTMENT

Radiographic examinations	51
Fluoroscopic	23
X-ray therapy	15
Total	89

NUMBER OF HOSPITALS MEETING THE MINIMUM STANDARD

	100 or more beds			50 to 100 beds			All hospitals over 50 beds		
	Number of hospitals	Approved		Number of hospitals	Approved		Number of hospitals	Approved	
		Number	Percentage		Number	Percentage		Number	Percentage
Alabama	10	9	90	17	6	35.3	27	15	55.6
Arizona	2	2	100	5	2	40	7	4	57.1
Arkansas	6	5	83.3	10	6	60	16	11	68.8
California	56	48	85.7	34	11	32.4	90	59	65.6
Colorado	12	12	100	9	4	44.4	21	16	76.2
Connecticut	16	16	100	12	4	33.3	28	20	74.3
Delaware	1	1	100	2	1	50	3	2	66.7
District of Columbia	12	10	83.3	1	..	....	13	10	76.9
Florida	6	3	50	9	3	33.3	15	6	40
Georgia	12	9	75	17	8	47.1	29	17	58.6
Idaho	1	1	100	8	6	75	9	7	77.8
Illinois	69	47	66.7	61	20	34.4	130	67	51.5
Indiana	22	18	81.8	15	10	66.7	37	28	75.7
Iowa	14	13	92.9	24	15	62.5	38	28	73.7
Kansas	6	6	100	28	17	60.7	34	23	67.6
Kentucky	8	8	100	18	9	50	26	17	69.2
Louisiana	7	7	100	11	8	72.7	18	15	83.3
Maine	5	5	100	11	4	36.4	16	9	56.3
Maryland	16	15	93.8	10	7	70	26	22	84.6
Massachusetts	49	44	89.8	34	20	58.8	83	64	77.1
Michigan	26	24	92.3	22	14	63.6	48	38	79.2
Minnesota	27	26	96.3	21	11	52.4	48	37	77.1
Mississippi	6	4	66.7	10	3	30	16	7	43.7
Missouri	35	26	74.3	19	10	52.6	54	36	66.7
Montana	9	7	77.8	9	5	55.6	18	12	66.7
Nebraska	12	8	66.7	13	4	30.8	25	12	48
Nevada	0	..	...	2	2	100	2	2	100
New Hampshire	2	1	50	12	10	83.3	14	11	78.6
New Jersey	38	36	94.7	13	10	76.9	51	46	90.2
New Mexico	0	..	...	5	4	80	5	4	80
New York	137	122	89	78	39	50	215	161	74.9
North Carolina	8	5	62.5	22	15	68.2	30	20	66.7
North Dakota	5	5	100	7	2	28.6	12	7	58.3
Ohio	44	42	95.5	37	24	64.9	81	66	81.5
Oklahoma	2	2	100	14	2	14.3	16	4	25
Oregon	5	5	100	14	4	28.6	19	9	47.4
Pennsylvania	89	79	88.7	82	38	46.3	171	117	68.4
Rhode Island	4	4	100	3	2	66.7	7	6	85.7
South Carolina	7	4	57.1	9	3	33.3	16	7	43.7
South Dakota	5	5	100	12	10	83.3	17	15	88.2
Tennessee	10	9	90	12	8	66.7	22	17	77.3
Texas	21	19	90.5	32	17	53.1	53	36	67.9
Utah	5	5	100	1	1	100	6	6	100
Vermont	1	1	100	5	4	80	6	5	83.3
Virginia	7	7	100	31	22	71	38	29	76.3
Washington	19	16	84.2	19	9	47.4	38	25	65.8
West Virginia	8	6	75	21	13	61.9	29	19	65.5
Wisconsin	27	22	81.5	26	11	42.3	53	33	62.3
Wyoming	2	..	...	6	3	50	8	3	37.5
Totals for United States	891	769	86.3	893	461	51.6	1784	1230	68.9
Alberta	7	7	100	4	4	100	11	11	100
British Columbia	7	7	100	7	3	42.9	14	10	71.4
Manitoba	9	9	100	1	..	....	10	9	90
New Brunswick	2	2	100	9	8	88.9	11	10	91
Nova Scotia	3	3	100	9	9	100	12	12	100
Ontario	26	20	76.9	30	11	36.7	56	31	55.4
P. E. I.	0	..	...	3	3	100	3	3	100
Quebec	11	10	91	9	5	55.6	19	15	78.9
Saskatchewan	5	4	80	8	4	50	13	8	61.5
Totals for Canada	70	62	88.6	80	47	58.8	149	109	72.6
Grand Totals	961	831	86.5	973	508	52.2	1933	1339	69.3

LIST OF HOSPITALS

Following is a list of approved hospitals for 1924 up to October 1. The asterisk indicates that certain hospitals have accepted the requirements which result in the best scientific care of the patient but are not, for the lack of time or other acceptable reasons, carrying them out in every detail.

ALABAMA

100 or more beds

Birmingham Baptist Hospital, Birmingham
Employees Hospital, T. C. I. R. R. Co., Birmingham
Hillman Hospital, Birmingham
Mobile City Hospital, Mobile
Moody Hospital, Dotham
Norwood Hospital, Birmingham
Providence Infirmary, Mobile
St. Vincent's Hospital, Birmingham
South Highlands Infirmary, Birmingham

50 to 100 beds

*Alabama Baptist Hospital, Selma
Children's Hospital, Birmingham
*Frazier Hospital, Dotham
John A. Andrew Memorial Hospital, Tuskegee
Vaughan Memorial Hospital, Selma
Walker County Hospital, Jasper

35 to 50 beds

*Sylacauga Infirmary, Sylacauga

ARIZONA

100 or more beds

Arizona Deaconess Hospital, Phoenix
St. Joseph's Hospital, Phoenix

50 to 100 beds

*Arizona Hospital and Sanatorium, Tucson
*St. Mary's Hospital and Sanitarium, Tucson

35 to 50 beds

Miami Inspiration Hospital, Miami

ARKANSAS

100 or more beds

Logan H. Roots City Memorial Hospital, Little Rock
St. Bernard's Hospital, Jonesboro
St. Louis Southwestern R. R. Hospital, Texarkana
St. Vincent's Infirmary, Little Rock
Sparks Memorial Hospital, Fort Smith

50 to 100 beds

Baptist Hospital, Little Rock
Fayetteville City Hospital, Fayetteville
Leo N. Levi Memorial Hospital, Hot Springs
Michael Meager Memorial Hospital, Texarkana
*St. John's Hospital, Fort Smith
St. Luke's Hospital and Annex, Little Rock

35 to 50 beds

*Helena Hospital, Helena

CALIFORNIA

100 or more beds

Alameda County Hospital, San Leandro
*Angelus Hospital Association, Los Angeles
California Lutheran Hospital, Los Angeles
Children's Hospital, Los Angeles
Fabiola Hospital, Oakland
*Franklin Hospital, San Francisco
French Hospital, San Francisco
General Hospital, Fresno
General Hospital, Santa Barbara
*Glendale Sanitarium and Hospital, Glendale
Golden State Hospital, Los Angeles
Hahnemann Hospital, San Francisco
Hollywood Hospital, Hollywood
Hospital for Children, San Francisco
Hospital of the Good Samaritan, Los Angeles
Kern General Hospital, Bakersfield
Loma Linda Sanitarium and Hospital, Loma Linda
Los Angeles General Hospital, Los Angeles
Mary's Help Hospital, San Francisco
Methodist Hospital, Los Angeles
Mt. Zion Hospital, San Francisco
O'Connor Sanitarium, San Jose
*Orange County Hospital, Orange
Paradise Valley Hospital, National City
Pasadena Hospital, Pasadena
Providence Hospital, Oakland
Sacramento Hospital, Sacramento
*St. Francis Hospital, San Francisco
*St. Francis Hospital, Santa Barbara
St. Helen's Sanitarium, Sanitarium
St. Joseph's Hospital, San Diego
St. Joseph's Hospital, San Francisco
St. Luke's Hospital, San Francisco
St. Mary's Hospital, San Francisco
St. Vincent's Hospital, Los Angeles
Samuel Merritt Hospital, Oakland
San Bernardino County Hospital, San Bernardino
San Diego County Hospital, San Diego
San Francisco Hospital, San Francisco
San Joaquin General Hospital, French Camp
Santa Barbara Cottage Hospital, Santa Barbara
Santa Clara County Hospital, San Jose
Santa Fe Coast Lines Hospital, Los Angeles
Seaside Hospital, Long Beach
Southern Pacific Hospital, San Francisco
Stanford University and Lane Hospitals, San Francisco
University of California Hospital, San Francisco
White Memorial Hospital, Los Angeles

50 to 100 beds

Clara Barton Hospital, Los Angeles
Community Hospital, San Mateo
Kaspare Cohn Hospital, Los Angeles
Mercy Hospital, Bakersfield
*Mills Memorial Hospital, San Mateo
Murphy Memorial Hospital, Whittier
Orthopædic Hospital, Los Angeles
Ramona and Sequoia Hospitals, San Bernardino
Shriners Orthopedic Hospital, San Francisco
St. Mary's Long Beach Hospital, Long Beach
Woodland Sanitarium, Woodland

35 to 50 beds

Baby's Hospital, Oakland
*Palo Alto Hospital, Palo Alto

COLORADO

100 or more beds

Beth-El Hospital, Colorado Springs
Boulder-Colorado Sanitarium, Boulder
Children's Hospital, Denver
Denver General Hospital, Denver
Glockner General Hospital, Colorado Springs
Mercy Hospital, Denver
Minnequa Hospital, Pueblo
St. Anthony's Hospital, Denver
St. Francis Hospital, Colorado Springs
St. Joseph's Hospital, Denver
St. Luke's Hospital, Denver
St. Mary's Hospital, Pueblo

50 to 100 beds

Beth Israel Hospital, Denver
Community Hospital, Boulder
Denver and Rio Grande Western R. R. Hospital, Salida
*Red Cross Hospital, Salida

35 to 50 beds

Atchison, Topeka, and Santa Fe R. R. Hospital, La Junta
Parkview Hospital, Pueblo

CONNECTICUT

100 or more beds

Bridgeport Hospital, Bridgeport
Danbury Hospital, Danbury
Grace Hospital, New Haven
Greenwich Hospital, Greenwich
Hartford Hospital, Hartford
Hospital of St. Raphael, New Haven
Lawrence and Memorial Associated Hospitals, New London
Meriden Hospital, Meriden
Middlesex Hospital, Middleton
New Britain Hospital, New Britain
New Haven Hospital, New Haven
St. Francis Hospital, Hartford
St. Mary's Hospital, Waterbury
St. Vincent's Hospital, Bridgeport
Stamford Hospital, Stamford
Waterbury Hospital, Waterbury

50 to 100 beds

*Charlotte Hungerford Hospital, Torrington
Manchester Memorial Hospital, South Manchester
Mt. Sinai Hospital, Hartford
*Municipal Hospital, Hartford

DELAWARE

100 or more beds

Delaware Hospital, Wilmington

50 to 100 beds

Homeopathic Hospital, Wilmington

DISTRICT OF COLUMBIA

100 or more beds

Central Dispensary and Emergency Hospital, Washington
Children's Hospital, Washington
Columbia Hospital for Women, Washington
Freedman's Hospital, Washington
*Gallinger Municipal Hospital, Washington
Garfield Memorial Hospital, Washington
George Washington University Hospital, Washington
Georgetown University Hospital, Washington
Providence Hospital, Washington
Washington Sanitarium, Washington

FLORIDA

100 or more beds

Duval County Hospital, Jacksonville
Miami City Hospital, Miami
St. Luke's Hospital, Jacksonville

50 to 100 beds

*East Coast Hospital, St. Augustine
Faith Hospital, St. Petersburg
Gordon Keller Memorial Hospital, Tampa

35 to 50 beds

Bayside Hospital, Tampa
Riverside Hospital, Jacksonville

GEORGIA

100 or more beds

Davis-Fischer Hospital, Atlanta
Georgia Baptist Hospital, Atlanta
Grady Memorial Hospital, Atlanta
Harbin Hospital, Rome
Piedmont Sanitarium, Atlanta
*Rawlings Sanitarium, Sandersville
St. Joseph's Infirmary, Atlanta
University Hospital, Augusta
Wesley Memorial Hospital, Atlanta

50 to 100 beds

Athens General Hospital, Athens
Atlantic Coast Lines Hospital, Waycross
Downey Hospital, Gainesville
*Dunson Hospital, LaGrange
Scottish Rite Hospital, Decatur
Thomasville City Hospital, Thomasville
*Wilhenford Hospital, Augusta
Wise Sanitarium, Plains

IDAHO

100 or more beds

St. Alphonsus Hospital, Boise

50 to 100 beds

Latter-Day Saints Hospital, Idaho Falls
Pocatello General Hospital, Pocatello
Providence Hospital, Wallace
St. Anthony's Hospital, Pocatello
St. Joseph's Hospital, Lewiston
St. Luke's Hospital, Boise

ILLINOIS

100 or more beds

Augustana Hospital, Chicago
Chicago Lying-in Hospital, Chicago
Chicago Memorial Hospital, Chicago
Children's Memorial Hospital, Chicago
Columbus Hospital, Chicago
Cook County Hospital, Chicago
*Emergency Hospital, Kankakee
Evanston Hospital, Evanston
Frances E. Willard Hospital, Chicago
Garfield Park Hospital, Chicago
Grant Hospital, Chicago

*Hinsdale Sanitarium, Hinsdale
Hospital of St. Anthony de Padua, Chicago
Illinois Central Hospital, Chicago
Illinois Eye and Ear Infirmary, Chicago
John B. Murphy Hospital, Chicago
Lake View Hospital, Danville
Lutheran Deaconess Hospital, Chicago
Lutheran Memorial Hospital, Chicago
Mercy Hospital, Chicago
Michael Reese Hospital, Chicago
Misericordia Hospital, Chicago
Mt Sinai Hospital, Chicago
Oak Park Hospital, Oak Park
Presbyterian Hospital Chicago
Ravenswood Hospital Chicago
Rockford Hospital, Rockford
St. Anne's Hospital, Chicago
*St. Anthony's Hospital, Rock Island
St. Bernard's Hospital, Chicago
St. Elizabeth's Hospital, Chicago
*St. Elizabeth's Hospital, Danville
St. Francis Hospital, Blue Island
St. Francis Hospital, Evanston
*St. Francis Hospital, Peoria
St. Joseph's Hospital, Chicago
St. Joseph's Hospital, Joliet
St. Luke's Hospital, Chicago
*St. Mary's Hospital, Cairo
St. Mary's Hospital, East St. Louis
St. Mary's Hospital, Quincy
St. Mary of Nazareth Hospital, Chicago
*Silver Cross Hospital, Joliet
South Shore Hospital, Chicago
Swedish Covenant Hospital, Chicago
University Hospital, Chicago
Wesley Memorial Hospital, Chicago

50 to 100 beds

Blessing Hospital, Quincy
Highland Park Hospital, Highland Park
Huber Memorial Hospital, Pana
Illinois Masonic Hospital, Chicago
Ingalls Memorial Hospital, Harvey
Kewanee Public Hospital, Kewanee
Lake View Hospital, Chicago
*Lutheran Hospital, Moline
*Moline Public Hospital, Moline
North Chicago Hospital, Chicago
Olney Sanitarium, Olney
Our Savior's Hospital, Jacksonville
*Passavant Memorial Hospital, Chicago
Passavant Memorial Hospital, Jacksonville
*Post-Graduate Hospital, Chicago
*Provident Hospital, Chicago
St. Andrew's Hospital, Murphysboro
*St. Francis Hospital, Freeport
*St. Francis Hospital, Kewanee
Washington Boulevard Hospital, Chicago

35 to 50 beds

Streeter Hospital, Chicago

INDIANA

100 or more beds

Fort Wayne Lutheran Hospital, Fort Wayne
Gary Hospital, Gary
Indianapolis City Hospital, Indianapolis
*Methodist Episcopal Hospital, Indianapolis
*Methodist Hospital, Gary
Protestant Deaconess Hospital, Evansville
Robert W. Long Hospital, Indianapolis
St. Anthony's Hospital, Terre Haute
St. Edward's Hospital, New Albany
St. Elizabeth's Hospital, LaFayette
St. Joseph's Hospital, Ft. Wayne
*St. Joseph's Hospital, Mishawaka
St. Joseph's Hospital, South Bend
St. Margaret's Hospital, Hammond
St. Mary's Hospital, Evansville
St. Mary's Mercy Hospital, Gary
*St. Vincent's Hospital, Indianapolis
Union Hospital, Terre Haute

50 to 100 beds

Epworth Hospital, South Bend
Grant County Hospital, Marion
Holy Family Hospital, LaPorte
LaFayette Home Hospital, LaFayette
Muncie Home Hospital, Muncie
Reid Memorial Hospital, Richmond
St. John's Hospital, Anderson
*St. Joseph's Hospital, Logansport
*Wabash Valley Sanitarium and Hospital, LaFayette
Walker Hospital, Evansville

35 to 50 beds

*Hayden Hospital, Evansville

IOWA

100 or more beds

Finley Hospital, Dubuque
Iowa Lutheran Hospital, Des Moines
Iowa Methodist Hospital, Des Moines
Jennie Edmundson Hospital, Council Bluffs
Mercy Hospital, Cedar Rapids
Mercy Hospital, Council Bluffs
Mercy Hospital, Davenport
*Mercy Hospital, Des Moines
*Mercy Hospital, Iowa City
St. Joseph's Hospital, Dubuque
St. Joseph's Mercy Hospital, Sioux City
St. Vincent's Hospital, Sioux City
University Hospital, Iowa City

50 to 100 beds

Des Moines City Hospital, Des Moines
Iowa Congregational Hospital, Des Moines
Iowa State College Hospital, Ames
*Jane Lamb Memorial Hospital, Clinton
*Lutheran Hospital, Sioux City
Methodist Hospital, Sioux City
*Ottumwa Hospital, Ottumwa
Park Hospital, Mason City
St. Francis Hospital, Waterloo
*St. Joseph's Hospital, Keokuk
St. Joseph's Mercy Hospital, Clinton
St. Joseph's Mercy Hospital, Ft. Dodge
St. Joseph's Mercy Hospital, Mason City
St. Joseph's Mercy Hospital, Waverly
St. Luke's Hospital, Cedar Rapids

35 to 50 beds

*Davenport Hospital, Davenport

KANSAS

100 or more beds

Bethany Methodist Hospital, Kansas City
St. Francis Hospital, Wichita

St. Margaret's Hospital, Kansas City
Santa Fe Hospital, Topeka
Wesley Hospital, Wichita
*Wichita Hospital, Wichita

50 to 100 beds

Axtell Hospital, Newton
Bell Memorial Hospital, Kansas City
Bethel Deaconess Hospital, Newton
Christ Hospital, Topeka
Grace Hospital, Hutchinson
Halstead Hospital, Halstead
*Missouri, Kansas, and Texas R. R. Hospital, Parsons
Mount Carmel Hospital, Pittsburg
Providence Hospital, Kansas City
St. Anthony's Hospital, Hays
St. Anthony's Murdock Memorial Hospital, Sabetha
St. Elizabeth's Hospital, Hutchinson
St. Francis Hospital, Topeka
St. John's Hospital, Salina
St. Joseph's Hospital, Concordia
*St. Mary's Hospital, Winfield
St. Rose's Hospital, Great Bend

35 to 50 beds

St. Luke's Hospital, El Dorado

KENTUCKY

100 or more beds

Good Samaritan Hospital, Lexington
Louisville City Hospital, Louisville
Norton Memorial Hospital, Louisville
St. Anthony's Hospital, Louisville
St. Elizabeth's Hospital, Covington
St. Joseph's Hospital, Lexington
St. Joseph's Infirmary, Louisville
Sts. Elizabeth and Mary Hospital, Louisville

50 to 100 beds

*Ashland General Hospital, Ashland
*Booth Memorial Hospital, Covington
*Children's Free Hospital, Louisville
*Jewish Hospital, Louisville
Illinois Central Hospital, Paducah
*King's Daughters Hospital, Ashland
Methodist Episcopal Hospital, Louisville
Speers Memorial Hospital, Dayton
Wm. Mason Memorial Hospital, Murray

35 to 50 beds

Robinson Hospital, Berea

LOUISIANA

100 or more beds

Charity Hospital, New Orleans
*Charity Hospital, Shreveport
Hotel Dieu, New Orleans
*Presbyterian Hospital, New Orleans
St. Francis Sanitarium, Monroe
T. E. Schumpert Memorial Hospital, Shreveport
Touro Infirmary, New Orleans

50 to 100 beds

*Baptist Hospital, Alexandria
Eye, Ear, Nose, and Throat Hospital, New Orleans
Flint-Goodridge Hospital, New Orleans
Highland Sanitarium, Shreveport
Illinois Central R. R. Hospital, New Orleans
North Louisiana Sanitarium, Shreveport
St. Patrick's Sanitarium, Lake Charles
Shriner's Hospital for Crippled Children, Shreveport

35 to 50 beds

*New Orleans Dispensary for Women and Children, New Orleans

MAINE

100 or more beds

Central Maine General Hospital, Lewiston
Eastern Maine General Hospital, Bangor
*Maine Eye and Ear Infirmary, Portland
Maine General Hospital, Portland
St. Mary's General Hospital, Lewiston

50 to 100 beds

Bath City Hospital, Bath
Children's Hospital, Portland
*St. Barnabas Hospital, Portland
*State Street Hospital, Portland

MARYLAND

100 or more beds

Allegany Hospital, Cumberland
Bay View City Hospital, Baltimore
Church Home and Infirmary, Baltimore
Colonial Hospital, Baltimore
*Franklin Square Hospital, Baltimore
Hebrew Hospital and Asylum, Baltimore
Hospital for Women of Maryland, Baltimore
Johns Hopkins Hospital, Baltimore
Maryland General Hospital, Baltimore
Mercy Hospital, Baltimore
*Peninsula General Hospital, Salisbury
St. Agnes Hospital, Baltimore
St. Joseph's Hospital, Baltimore
Union Memorial Hospital, Baltimore
University Hospital, Baltimore

50 to 100 beds

*Cambridge-Maryland Hospital, Cambridge
Children's Hospital School, Baltimore
Emergency Hospital, Easton
Frederick City Hospital, Frederick
*James Lawrence Kerman Hospital, Baltimore
South Baltimore Hospital, Baltimore
Western Maryland Hospital, Cumberland

35 to 50 beds

Howard A. Kelley Hospital, Baltimore
Volunteers of America Hospital, Baltimore

MASSACHUSETTS

100 or more beds

Beverly Hospital, Beverly
Boston City Hospital, Boston
Boston Lying-in Hospital, Boston
Brockton Hospital, Brockton
Burbank Hospital, Fitchburg
Cambridge City Hospital, Cambridge
Cambridge Hospital, Cambridge
Carney Hospital, Boston
Children's Hospital, Boston
City Hospital, Fall River
Cooley-Dickinson Hospital, Northampton
Free Hospital for Women, Boston
Gale Hospital, Haverhill

Henry Heywood Memorial Hospital, Gardiner
Holyoke City Hospital, Holyoke
House of Mercy Hospital, Pittsfield
Lawrence General Hospital, Lawrence
Long Island Hospital, Boston
Lowell Corporation Hospital, Lowell
Lowell General Hospital, Lowell
Lynn Hospital, Lynn
Malden Hospital, Malden
Massachusetts Charitable Eye and Ear Hospital, Boston
Massachusetts General Hospital, Boston
Massachusetts Homeopathic Hospital, Boston
Memorial Hospital, Worcester
Mercy Hospital, Springfield
New England Deaconess Hospital, Boston
New England Hospital for Women and Children, Boston
Newton Hospital, Newton Lower Falls
Noble Hospital, Westfield
Peter Bent Brigham Hospital, Boston
Providence Hospital, Holyoke
Robert Breck Brigham Hospital, Boston
St. Elizabeth's Hospital, Boston
St. John's Hospital, Lowell
St. Luke's Hospital, Bedford
St. Vincent's Hospital, Worcester
Salem Hospital, Salem
Springfield Hospital, Springfield
Truesdale Hospital, Fall River
Union Hospital, Fall River
Waltham Hospital, Waltham
Worcester City Hospital, Worcester

50 to 100 beds

Anna Jaques Hospital, Newburyport
Beth Israel Hospital, Boston
Charles Choate Memorial Hospital, Woburn
*Chelsea Memorial Hospital, Chelsea
*City Hospital, Quincy
Clinton Hospital, Clinton
*Emerson Hospital, Boston
Farren Memorial Hospital, Montague City
Faulkner Hospital, Boston
Goddard Hospital, Brockton
*Hale Hospital, Haverhill
*Hart Private Hospital, Roxbury
House of the Good Samaritan, Boston
Infant's Hospital, Boston
*Josiah B. Thomas Hospital, Peabody
Melrose Hospital, Melrose
North Adams Hospital, North Adams
Somerville Hospital, Somerville
*Sturdy Memorial Hospital, Attleboro
*Symmes Arlington Hospital, Arlington

35 to 50 beds

New England Deaconess Hospital, Boston

MICHIGAN

100 or more beds

Battle Creek Sanitarium, Battle Creek
Blodgett Memorial Hospital, Grand Rapids
Butterworth Hospital, Grand Rapids
Children's Free Hospital, Detroit
Detroit Receiving Hospital, Detroit
Evangelical Deaconess Hospital, Detroit
Grace Hospital, Detroit
Edward W. Sparrow Hospital, Lansing
Harper Hospital, Detroit
Hackley Hospital, Muskegon
Henry Ford Hospital, Detroit
Highland Park General Hospital, Highland Park
House of Providence, Detroit
Hurley Hospital, Flint
Mercy Hospital, Muskegon
New Borgess Hospital, Kalamazoo
Old Borgess Hospital, Kalamazoo
St. Joseph's Hospital, Ann Arbor
St. Mary's Hospital, Grand Rapids
St. Mary's Hospital, Detroit
Saginaw General Hospital, Saginaw
University Hospital, Ann Arbor
W. A. Foot Memorial Hospital, Jackson
Women's Hospital and Infant's Home, Detroit

50 to 100 beds

Bronson Hospital, Kalamazoo
Delray Industrial Hospital, Detroit
Detroit Eye and Ear Hospital, Detroit
Jefferson Clinic Hospital, Detroit
Memorial Hospital, Owosso
*Mercy Hospital, Cadillac
Mercy Hospital, Jackson
*St. Francis Hospital, Escanaba
St. Joseph's Hospital, Hancock
St. Joseph's Hospital, Detroit
St. Joseph's Hospital, Mt. Clemens
*St. Mary's Hospital, Marquette
St. Mary's Hospital, Saginaw
Woman's Hospital, Saginaw

35 to 50 beds

Ishpeming Hospital, Ishpeming

MINNESOTA

100 or more beds

Abbott Hospital, Minneapolis
Ancker Hospital, St. Paul
Asbury Hospital, Minneapolis
Bethesda Hospital, St. Paul
Charles T. Miller Hospital, St. Paul
Colonial Hospital, Rochester
Deaconess Hospital, Minneapolis
Eitel Hospital, Minneapolis
Fairview Hospital, Minneapolis
Kahler Hospital, Rochester
Minneapolis General Hospital, Minneapolis
Minnesota State Hospital for Indigent Children, St. Paul
Mounds Park Sanitarium, St. Paul
Northern Pacific Beneficial Association Hospital, St. Paul
*Northwestern Hospital, Minneapolis
St. Barnabas Hospital, Minneapolis
St. Joseph's Hospital, St. Paul
St. Luke's Hospital, Duluth
St. Luke's Hospital, St. Paul
St. Mary's Hospital, Duluth
St. Mary's Hospital, Minneapolis
St. Mary's Hospital, Rochester
St. Paul Hospital, St. Paul
Swedish Hospital, Minneapolis
University of Minnesota Hospital, Minneapolis
Worrell Hospital, Rochester

50 to 100 beds

Hill Crest Surgical Hospital, Minneapolis
*Immanuel Hospital, Mankato
*St. Gabriel's Hospital, Little Falls
St. John's Hospital, St. Paul
St. Joseph's Hospital, Brainerd

St. Joseph's Hospital, Mankato
St. Luke's Hospital, Fergus Falls
St. Raphael's Hospital, St. Cloud
Shriners Hospital for Crippled Children, Minneapolis
Warren General Hospital, Warren
Winona General Hospital, Winona

35 to 50 beds

Morgan Park Hospital, Duluth

MISSISSIPPI

100 or more beds

Kings Daughters Hospital, Gulfport
Matty Hersee Hospital, Meridian
Mississippi State Charity Hospital, Jackson
South Mississippi Charity Hospital, Laurel

50 to 100 beds

Jackson Infirmary, Jackson
Mississippi Baptist Hospital, Jackson
Vicksburg Infirmary, Vicksburg

35 to 50 beds

Dr. Hairston's Hospital, Meridian
J. Z. George Memorial Hospital, A. and M. College
Houston Hospital, Houston
South Mississippi General Hospital, Hattiesburg
Winona Infirmary, Winona

MISSOURI

100 or more beds

Alexian Brothers Hospital, St. Louis
Barnes Hospital, St. Louis
Bethesda Hospital, St. Louis
Children's Hospital, Kansas City
Christian Church Hospital, Kansas City
*Evangelical Deaconess Home and Hospital, St. Louis
Grace Hospital, Kansas City
Frisco Employees Hospital, St. Louis
Jewish Hospital, St. Louis
Kansas City General Hospital, Kansas City
Lutheran Hospital, St. Louis
Missouri Baptist Sanitarium, St. Louis
Missouri Pacific R. R. Hospital, St. Louis
Old General Hospital, Kansas City
Research Hospital, Kansas City
St. Anthony's Hospital, St. Louis
St. John's Hospital, St. Louis
St. Joseph's Hospital, Kansas City
St. Louis Children's Hospital, St. Louis
St. Louis City Hospital, St. Louis
St. Louis City Hospital, No. 2, St. Louis
St. Louis Mullanphy Hospital, St. Louis
St. Luke's Hospital, Kansas City
St. Luke's Hospital, St. Louis
St. Mary's Infirmary, St. Louis
St. Mary's Hospital, Kansas City

50 to 100 beds

Boone County Hospital, Columbia
Frisco Employees Hospital, Springfield
Independence Sanitarium, Independence
Parker Memorial Hospital, Columbia
St. Francis Hospital, Cape Girardeau
St. Francis Hospital, Maryville
St. John's Hospital, Joplin
St. Louis Baptist Hospital, St. Louis
St. Mary's Hospital, Jefferson City
*Trinity Lutheran Hospital, Kansas City

35 to 50 beds

Barnard Free Skin and Cancer Hospital, St. Louis
St. Louis Maternity Hospital, St. Louis
Wheatley Provident Hospital, Kansas City

MONTANA

100 or more beds

Columbus Hospital, Great Falls
Holy Rosary Hospital, Miles City
Montana Deaconess Hospital, Great Falls
Murray Hospital, Butte
St. James Hospital, Butte
St. Patrick's Hospital, Missoula
St. Vincent's Hospital, Billings

50 to 100 beds

*Northern Pacific Beneficial Association Hospital, Glendive
Northern Pacific Beneficial Association Hospital, Missoula
St. Ann's Hospital, Anaconda
*St. John's Hospital, Helena
St. Joseph's Hospital, Lewistown

NEBRASKA

100 or more beds

Bishop Clarkson Memorial Hospital, Omaha
Nebraska Methodist Episcopal Hospital, Omaha
Nebraska Orthopedic Hospital, Lincoln
St. Elizabeth's Hospital, Lincoln
St. Francis Hospital, Grand Island
St. Joseph's Hospital, Omaha
St. Mary's Hospital, Columbus
University of Nebraska Hospital, Omaha

50 to 100 beds

Immanuel Hospital, Omaha
*St. Joseph's Hospital, Alliance
Swedish Mission Hospital, Omaha
Wise Memorial Hospital, Omaha

NEVADA

50 to 100 beds

Elko General Hospital, Elko
St. Mary's Hospital, Reno

35 to 50 beds

Steptoe Valley Hospital, East Ely

NEW HAMPSHIRE

100 or more beds

St. Joseph's Hospital, Nashua

50 to 100 beds

*Claremont Hospital, Claremont
Elliott Community Hospital, Keene
Elliott Hospital, Manchester
*Laconia Hospital, Laconia
*Margaret Pillsbury General Hospital, Concord
Mary Hitchcock Memorial Hospital, Hanover
Nashua Memorial Hospital, Nashua
Notre Dame Hospital, Manchester
*Portsmouth Hospital, Portsmouth
Sacred Heart Hospital, Manchester

NEW JERSEY

100 or more beds

Alexian Brothers Hospital, Elizabeth
All Souls' Hospital, Morristown
Atlantic City Hospital, Atlantic City
Bayonne Hospital and Dispensary, Bayonne
Christ Hospital, Jersey City
Cooper Hospital, Camden
Elizabeth General Hospital, Elizabeth
Englewood Hospital, Englewood
Hackensack Hospital, Hackensack
Jersey City Hospital, Jersey City
Mercer Hospital, Trenton
Monmouth Memorial Hospital, Long Branch
Morristown Memorial Hospital, Morristown
Mountainside Hospital, Montclair
Muhlenberg Hospital, Plainfield
Newark Beth Israel Hospital, Newark
Newark City Hospital, Newark
Newark Memorial Hospital, Newark
Newark Presbyterian Hospital, Newark
Orange Memorial Hospital, Newark
*Passaic General Hospital, Passaic
Paterson General Hospital, Paterson
Perth Amboy City Hospital, Perth Amboy
St. Barnabas Hospital, Newark
St. Elizabeth's Hospital, Elizabeth
St. Francis Hospital, Jersey City
St. Francis Hospital, Trenton
St. James Hospital, Newark
St. Joseph's Hospital, Paterson
*St. Gerard's Italian Hospital, Newark
St. Mary's Hospital, Hoboken
St. Mary's Hospital, Orange
St. Mary's Hospital, Passaic
St. Michael's Hospital, Newark
St. Peter's General Hospital, New Brunswick
*West Jersey Homeopathic Hospital, Camden

50 to 100 beds

Ann May Memorial Hospital, Spring Lake
Homeopathic Hospital, Newark
*Hospital for Women and Children, Newark
Mariam and Nathan Barnert Memorial Hospital, Paterson
Middlesex General Hospital, New Brunswick
*Newcomb Hospital, Vineland
Newark Eye and Ear Infirmary, Newark
North Hudson Hospital, Weehawken
*Overlook Hospital, Summitt
William McKinley Memorial Hospital, Trenton

35 to 50 beds

*Burlington County Hospital, Mt. Holly

NEW MEXICO

50 to 100 beds

St. Joseph's Hospital, Albuquerque
*St. Mary's Hospital, Gallup
*St. Mary's Hospital, Roswell
St. Vincent's Hospital, Santa Fe

NEW YORK

100 or more beds

Albany Hospital, Albany
*Arnot-Ogden Memorial Hospital, Elmira
Auburn City Hospital, Auburn
Bellevue Hospital, New York City
Beth David Hospital, New York City
Beth Israel Hospital, New York City
Beth Moses Hospital, Brooklyn
Binghamton Hospital, Binghamton
Broad Street Hospital, New York City
Bronx Hospital, New York City
Brooklyn Hospital, Brooklyn
Brownsville and East New York Hospital, Brooklyn
Buffalo City Hospital, Buffalo
Buffalo General Hospital, Buffalo
Buffalo Hospital of Sisters of Charity, Buffalo
Bushwick Hospital, Brooklyn
Carson C. Peck Memorial Hospital, Brooklyn
Children's Hospital, Buffalo
Columbus Extension Hospital, New York City
Community Hospital, New York City
Coney Island Hospital, Brooklyn
*Crouse-Irving Hospital, Syracuse
Cumberland Street Hospital, Brooklyn
Deaconess Home and Hospital, Buffalo
Ellis Hospital, Schenectady
Faxton Hospital, Utica
Fifth Avenue Hospital, New York City
Flower Hospital, New York City
Flushing Hospital and Dispensary, Flushing
Fordham Hospital, New York City
French Benevolent Society Hospital, New York City
Gouverneur Hospital, New York City
Grasslands Hospital, Valhalla
Greenpoint Hospital, Brooklyn
Harlem Hospital, New York City
Highland Hospital, Rochester
Hospital of the Good Shepherd, Syracuse
Holy Family Hospital, Brooklyn
House of Good Samaritan, Watertown
Hospital for Deformities and Joint Diseases, New York City
*Ithaca City Hospital, Ithaca
Jewish Hospital, Brooklyn
Jewish Maternity Hospital, New York City
*Jewish Memorial Hospital, New York City
King's County Hospital, Brooklyn
Knickerbocker Hospital, New York City
*Lawrence Hospital, Bronxville
Lebanon Hospital, New York City
Lenox Hill Hospital, New York City
Lincoln Hospital, New York City
*Long Island College Hospital, Brooklyn
*Lutheran Hospital of Manhattan, New York City
Manhattan Eye and Ear Hospital, New York City
Mary Imogene Bassett Hospital, Cooperstown
Memorial Hospital for Cancer and Allied Diseases, New York City
Memorial Hospital, Albany
Methodist Episcopal Hospital, Brooklyn
Metropolitan Hospital, New York City
*Millard Fillmore Hospital, Buffalo
Misericordia Hospital, New York City
Mt. St. Mary's Hospital, Niagara Falls
Mt. Sinai Hospital, New York City
Mt. Vernon Hospital, Mt. Vernon
Montefiore Hospital, New York City
Nassau Hospital, Mineola, Long Island
New Rochelle Hospital, New Rochelle
New York City Hospital, Blackwell's Island, New York City
New York Eye and Ear Infirmary, New York City
New York Foundling Home, New York City
New York Hospital, New York City

New York Infirmary for Women and Children, New York City
New York Nursery and Children's Hospital, New York City
New York Orthopedic Hospital, New York City
New York Orthopedic Hospital for Children, West Haverstraw
*New York Polyclinic Hospital, New York City
New York Post Graduate Hospital, New York City
New York Hospital for Ruptured and Crippled, New York City
New York Skin and Cancer Hospital, New York City
Niagara Falls Memorial Hospital, Niagara Falls
Norwegian Lutheran Deaconess Hospital, Brooklyn
Olean General Hospital, Olean
Oneida County Hospital, Rome
Park Avenue Clinical Hospital, Rochester
Presbyterian Hospital, New York City
Prospect Heights Hospital, New York City
Rochester General Hospital, Rochester
Rochester Homeopathic Hospital, Rochester
Roosevelt Hospital, New York City
*Sailors Snug Harbor Hospital, New Brighton
St. Catherine's Hospital, Brooklyn
St. Elizabeth's Hospital and Home, Utica
St. Francis Hospital, New York City
St. John's Brooklyn Hospital, Brooklyn
St. John's Hospital, Long Island
*St. John's Riverside Hospital, Yonkers
*St. Joseph's Hospital, Syracuse
St. Luke's Hospital, New York City
*St. Luke's Hospital, Newburgh
*St. Luke's Hospital, Utica
St. Mark's Hospital, New York City
*St. Mary's Maternity Hospital, Buffalo
St. Mary's Free Hospital for Children, New York City
St. Mary's Hospital, Brooklyn
St. Mary's Hospital, Rochester
St. Peter's Hospital, Albany
St. Peter's Hospital, Brooklyn
St. Vincent's Hospital, New York City
Samaritan Hospital, Troy
Saratoga Hospital, Saratoga Springs
Sloane Hospital for Women, New York City
Soldiers and Sailors Memorial Hospital, Utica
Staten Island Hospital, Tompkinsville
Syracuse Memorial Hospital, Syracuse
The Sanitarium, Clifton Springs
Troy Hospital, Troy
United Hospital, Port Chester
United Israel Zion Hospital, Brooklyn
Vassar Brothers Hospital, Poughkeepsie
*White Plains Hospital, White Plains
Woman's Hospital, New York City
Wyckoff Heights Hospital, Brooklyn
Yonkers Homeopathic Hospital and Maternity Home, Yonkers

50 to 100 beds

*Alice Hyde Memorial Hospital, Malone
Amsterdam City Hospital, Amsterdam
Anthony Brady Hospital, Albany
*Aurelia Osborn Fox Memorial Hospital, Oneonta
Babies Hospital, New York City
*Beekman Street Hospital, New York City
*Bethesda Hospital, Hornell
*Broad Street Hospital, Oneida
*Brooklyn Eye and Ear Hospital, Brooklyn
*Champlain Valley Hospital, Plattsburg
City Hospital, Kingston
Columbus Hospital, New York City
*Dobbs Ferry Hospital, Dobbs Ferry
Emergency Hospital of Sisters of Charity, Buffalo
General Hospital, Syracuse
*Geneva City Hospital, Geneva
Glens Falls Hospital, Glens Falls
Harbor Hospital, Brooklyn
Hudson City Hospital, Hudson
*Italian Benevolent Hospital, New York City
Jamaica Hospital, Jamaica
*Leonard Hospital, Troy
Manhattan Maternity Hospital, New York City
Mary Immaculate Hospital, Jamaica
Mary McClellan Hospital, Cambridge
*Nathan Littauer Hospital, Gloversville
Neurological Institute, New York City
*New York Ophthalmic Hospital, New York City
Ossining Hospital, Ossining
Peoples Hospital, New York City
Rockefeller Institute, New York City
Reconstruction Hospital, New York City
Rome Hospital, Rome
St. Bartholomew's Hospital, New York City
St. Joseph's Hospital, Yonkers
*St. Mary's Hospital, Amsterdam
St. Vincent's Hospital, West New Brighton
Southampton Hospital, Southampton
*Swedish Hospital, Brooklyn

35 to 50 beds

Lexington Hospital, New York City
*Southside Hospital, Bayshore

NORTH CAROLINA

100 or more beds

*Asheville Mission Hospital, Asheville
*James Walker Memorial Hospital, Wilmington
Rex Hospital, Raleigh
*St. Leo's Hospital, Greensboro
Watts Hospital, Durham

50 to 100 beds

Atlantic Coast Lines R. R. Hospital, Rocky Mount
*City Hospital, Winston-Salem
*French Broad Hospital, Asheville
Highpoint Hospital, Highpoint
Highsmith Hospital, Fayetteville
Long's Sanitarium, Statesville
Martin Memorial Hospital, Mt. Airy
*Mercy General Hospital, Charlotte
*Meriwether Hospital, Asheville
North Carolina Orthopedic Hospital, Gastonia
Parkview Hospital, Rocky Mount
Pitt Community Hospital, Greenville
Pittman Hospital, Fayetteville
Rutherford Hospital, Rutherfordton
*Salisbury Hospital, Salisbury

35 to 50 beds

*Biltmore Hospital, Biltmore
Bullock Hospital, Wilmington
Cumberland General Hospital, Fayetteville
*Edgecomb General Hospital, Tarboro
Lawrence Hospital, Winston-Salem
*More Heiring Hospital, Wilson
Parrott Memorial Hospital, Winston
Richard Baker Hospital, Hickory
Wesley Long Memorial Hospital, Greensboro

NORTH DAKOTA

100 or more beds

Bismarck Evangelical Deaconess Hospital, Bismarck
Grand Forks Deaconess Hospital, Grand Forks
St. Alexius Hospital, Bismarck
*St. John's Hospital, Fargo
St. Luke's Hospital, Fargo

50 to 100 beds

*St. Joseph's Hospital, Minot
St. Michael's Hospital, Grand Forks

OHIO

100 or more beds

Alliance Hospital, Alliance
Aultman Hospital, Canton
Bethesda Hospital, Cincinnati
Christ Hospital, Cincinnati
Cincinnati General Hospital, Cincinnati
City Hospital, Akron
Cleveland City Hospital, Cleveland
*Cleveland Maternity Hospital, Cleveland
*Glenville Hospital, Cleveland
Good Samaritan Hospital, Cincinnati
*Good Samaritan Hospital, Zanesville
Grant Hospital, Columbus
Hawkes Hospital of Mt. Carmel, Columbus
Huron Road Hospital, Cleveland
Jewish Hospital, Cincinnati
Lakeside Hospital, Cleveland
Lucas County Hospital, Toledo
Lutheran Hospital, Cleveland
Massillon City Hospital, Massillon
Mercy Hospital, Hamilton
Mercy Hospital, Toledo
Miami Valley Hospital, Dayton
Mt. Sinai Hospital, Cleveland
*Peoples Hospital, Akron
St. Alexis Hospital, Cleveland
*St. Ann's Infant Asylum and Maternity Hospital, Cleveland
*St. Elizabeth's Hospital, Dayton
St. Elizabeth's Hospital, Youngstown
*St. Francis Hospital, Columbus
St. John's Hospital, Cleveland
*St. Joseph's Hospital, Lorain
St. Luke's Hospital, Cleveland
St. Mary's Hospital, Cincinnati
St. Rita's Hospital, Lima
St. Vincent's Hospital, Cleveland
St. Vincent's Hospital, Toledo
Springfield City Hospital, Springfield
Starling-Loring University Hospital, Columbus
Toledo Hospital, Toledo
Youngstown Hospital, Youngstown
White Cross Hospital, Columbus
Woman's Hospital, Cleveland

50 to 100 beds

Bellaire City Hospital, Bellaire
Children's Hospital, Cincinnati
Children's Hospital, Columbus
Deaconess Hospital, Cincinnati
*Fairview Hospital, Cleveland
Flower Hospital, Toledo
Good Samaritan Hospital, Sandusky
*Hospital Clinic Company, Cleveland
Lakewood Hospital, Lakewood
Lima City Hospital, Lima
Mansfield General Hospital, Mansfield
Martin's Ferry Hospital, Martin's Ferry
Mary Day Nursery and Children's Hospital, Akron
Maternity and Children's Hospital, Toledo
*Memorial Hospital, Fremont
Mercy Hospital, Columbus
Mercy Hospital, Canton
Newark City Hospital, Newark
*Ohio Valley Hospital, Steubenville
Robinwood Hospital, Toledo
Salem Hospital, Salem
Schirrman Hospital, Portsmouth
Seton Hospital. Cincinnati
Warren City Hospital, Warren

OKLAHOMA

100 or more beds

St. Anthony's Hospital, Oklahoma City
State University Hospital, Oklahoma City

50 to 100 beds

*El Reno Sanitarium, El Reno
*Morningside Hospital, Tulsa
*Wesley Hospital, Oklahoma City

35 to 50 beds

*Ponca City Hospital, Ponca City

OREGON

100 or more beds

Emanuel Hospital, Portland
Good Samaritan Hospital, Portland
Multnomah County Hospital, Portland
Portland Sanitarium, Portland
St. Vincent's Hospital, Portland

50 to 100 beds

Mercy Hospital, Eugene
Portland Surgical Hospital, Portland
Sacred Heart Hospital, Medford
St. Mary's Hospital, Astoria

PENNSYLVANIA

100 or more beds

Abington Hospital, Abington
Allegheny General Hospital, Pittsburgh
Allentown Hospital, Allentown
Altoona Hospital, Altoona
Braddock General Hospital, Braddock
Bryn Mawr Hospital, Bryn Mawr
Chester County Hospital, West Chester
Chester Hospital, Chester
Chestnut Hill Hospital, Philadelphia
Children's Homeopathic Hospital, Philadelphia
Clearfield Hospital, Clearfield
Columbia Hospital, Pittsburgh
Conemaugh Valley Memorial Hospital, Johnstown
Easton Hospital, Easton
Elizabeth Steel Magee Hospital, Pittsburgh
Frankford Hospital, Philadelphia
George F. Geisinger Hospital, Danville
Germantown Dispensary and Hospital, Philadelphia
Hahnemann Hospital, Scranton
Hahnemann Medical and Surgical Hospital, Philadelphia
Hamot Hospital, Erie
Harrisburg Hospital, Harrisburg

Hazleton State Hospital, Hazleton
Homeopathic Medical and Surgical Hospital, Pittsburgh
Hospital of the Protestant Episcopal Church, Philadelphia
Hospital of the University of Pennsylvania, Philadelphia
Hospital of the Women's Medical College, Philadelphia
J. Lewis Crozier Hospital, Chester
Jefferson Hospital, Philadelphia
*Jewish Hospital, Philadelphia
Lancaster General Hospital, Lancaster
Lankenau Hospital, Philadelphia
Medico Chirurgical Hospital, Philadelphia
Memorial Hospital, Roxborough
Mercy Hospital, Altoona
Mercy Hospital, Johnstown
Mercy Hospital, Philadelphia
Mercy Hospital, Pittsburgh
Mercy Hospital, Wilkes-Barre
Methodist Episcopal Hospital, Philadelphia
Misericordia Hospital, Philadelphia
Moses Taylor Hospital, Scranton
Mt. Sinai Hospital, Philadelphia
Passavant Hospital, Pittsburgh
Pennsylvania Hospital, Philadelphia
Philadelphia General Hospital, Philadelphia
Philadelphia Polyclinic Hospital, Philadelphia
Pittsburgh Hospital, Pittsburgh
Pottsville Hospital, Pottsville
Presbyterian Hospital, Philadelphia
Presbyterian Hospital, Pittsburgh
Reading Hospital, Reading
Robert Packer Hospital, Sayre
Sacred Heart Hospital, Allentown
St. Agnes Hospital, Philadelphia
St. Francis Hospital, Pittsburgh
St. John's General Hospital, Pittsburgh
St. Joseph's Hospital, Lancaster
St. Joseph's Hospital, Philadelphia
St. Joseph's Hospital, Pittsburgh
St. Joseph's Hospital, Reading
*St. Joseph's Infant and Maternity Hospital, Scranton
St. Luke's Hospital, South Bethlehem
St. Margaret's Hospital, Pittsburgh
St. Mary's Hospital, Philadelphia
St. Vincent's Hospital, Erie
Samaritan Hospital, Philadelphia
Scranton State Hospital, Scranton
South Side Hospital, Pittsburgh
Uniontown Hospital, Uniontown
Washington Hospital, Washington
West Philadelphia Hospital for Women, Philadelphia
Western Pennsylvania Hospital, Pittsburgh
*Westmoreland Hospital, Greensburg
Wilkes-Barre City Hospital, Wilkes-Barre
Wills Hospital, Philadelphia
Women's Homeopathic Hospital, Philadelphia
Women's Hospital, Philadelphia
York Hospital and Dispensary, York

50 to 100 beds

Annie M. Warner Hospital, Gettysburg
Bainbridge Private Hospital, Philadelphia
Beaver Valley General Hospital, New Brighton
*Carlisle General Hospital, Carlisle
Children's Hospital, Philadelphia
Children's Hospital, Pittsburgh
Citizens General Hospital, New Kensington
*Columbia Hospital, Columbia
Cottage State Hospital, Blossburg
DuBois Hospital, DuBois
Eye and Ear Hospital, Pittsburgh
*Frederick Douglass Memorial Hospital, Philadelphia
Good Samaritan Hospital, Lebanon
Homeopathic Hospital, West Chester
Howard Hospital, Philadelphia
*Indiana Hospital, Indiana
J. C. Blair Memorial Hospital, Huntington
Jewish Maternity Hospital, Philadelphia
Joseph Price Memorial Hospital, Philadelphia
*Kane Summitt Hospital, Kane
*Lock Haven Hospital, Lock Haven
*Montgomery Hospital, Norristown
Montefiore Hospital, Pittsburgh
*New Castle Hospital, New Castle
Oil City Hospital, Oil City
Palmerton Hospital, Palmerton
Philadelphia Lying-in Charity Hospital, Philadelphia
Pittston Hospital, Pittston
*Polyclinic Hospital, Harrisburg
Providence Hospital, Beaver Falls
St. Luke's Homeopathic Hospital, Philadelphia
St. Vincent's Hospital, Philadelphia
Sewickley Valley Hospital, Sewickley
Shamokin Hospital, Shamokin
*State Hospital of Nanticoke, Nanticoke
Stetson Hospital, Philadelphia
Suburban Hospital, Bellevue
Windber Hospital, Windber

35 to 50 beds

Great Heart Maternity Hospital, Philadelphia
*Lee Homeopathic Hospital, Johnstown
West Side Sanitarium, Philadelphia

RHODE ISLAND

100 or more beds

*Newport Hospital, Newport
Providence City Hospital, Providence
Rhode Island Hospital, Providence
St. Joseph's Hospital, Providence

50 to 100 beds

*Memorial Hospital, Pawtucket
Providence Lying-in Hospital, Providence

SOUTH CAROLINA

100 or more beds

Florence Infirmary, Florence
Greenville City Hospital, Greenville
Roper Hospital, Charleston
South Carolina Baptist Hospital, Columbia

50 to 100 beds

Anderson County Hospital, Anderson
Baker Sanatorium, Charleston
St. Francis Xavier Infirmary, Charleston

35 to 50 beds

Orangeburg Hospital, Orangeburg

SOUTH DAKOTA

100 or more beds

Chamberlain Sanitarium and Hospital, Chamberlain
McKennan Hospital, Sioux Falls
Methodist State Hospital, Mitchell
Sacred Heart Hospital, Yankton
St. Luke's Hospital, Aberdeen

50 to 100 beds

Bartron Hospital, Watertown
Lincoln Hospital, Aberdeen
Luther Hospital, Watertown
*Methodist Deaconess Hospital, Rapid City
Moe Hospital, Sioux Falls
New Madison Hospital, Madison
Peabody Hospital, Webster
*St. Joseph's Hospital, Deadwood
St. Joseph's Hospital, Mitchell
St. Mary's Hospital, Pierre

TENNESSEE

100 or more beds

Baptist Memorial Hospital, Memphis
*Erlanger Hospital, Chattanooga
George W. Hubbard Hospital, Nashville
Knoxville General Hospital, Knoxville
Memphis General Hospital, Memphis
Nashville City Hospital, Nashville
St. Joseph's Hospital, Memphis
St. Thomas Hospital, Nashville
Vanderbilt Hospital, Nashville

50 to 100 beds

Appalachian Hospital, Johnson City
Baird-Dulaney Hospital, Dyersburg
Lucy Brinkley Hospital, Memphis
*Millie E. Hale Hospital, Nashville
Newell and Newell Sanitarium, Chattanooga
Protestant Hospital, Nashville
Riverside Hospital, Knoxville
Woman's Hospital of State of Tennessee, Nashville

35 to 50 beds

Crippled Children's Hospital, Memphis
Dr. W. C. Campbell's Hospital, Memphis

TEXAS

100 or more beds

Baylor Hospital, Dallas
Baptist Hospital, Houston
Central Texas Baptist Sanitarium, Waco
Hotel Dieu, Beaumont
John Sealy Hospital, Galveston
Methodist Hospital, Houston
Parkland Hospital, Dallas
*Providence Sanitarium, Waco
Robert B. Green Memorial Hospital, San Antonio
St. Joseph's Infirmary, Ft. Worth
St. Joseph's Infirmary, Houston
St. Mary's Infirmary, Galveston
St. Paul's Sanitarium, Dallas
Santa Fe Hospital, Temple
Santa Rosa Infirmary, San Antonio
Scott and White Hospital, Temple
Seton Infirmary, Austin
Southern Pacific Hospital, Houston
Wichita General Hospital, Wichita Falls

50 to 100 beds

All Saints' Hospital, Ft. Worth
*Baptist Hospital, Fort Worth
*City and County Hospital, Ft. Worth
*City and County Hospital, Houston
*Frances Ann Luther Hospital, Orange
Harris Sanitarium, Ft. Worth
Hella Temple Hospital, Dallas
International R. R. Hospital, Palestine
King's Daughters Hospital, Temple
*Lubbock Sanitarium, Lubbock
*Masonic Hospital, El Paso
*St. Joseph's Hospital, Paris
*Sanatorium of Paris, Paris
*Sherman Hospital, Sherman
*Spohn Sanitarium, Corpus Christi
Texarkana Sanitarium, Texarkana
*Texas and Pacific R. R. Hospital, Marshall

35 to 50 beds

McKinney City Hospital, McKinney

UTAH

100 or more beds

Doctor W. H. Groves Latter Day Saint's Hospital, Salt Lake City
Holy Cross Hospital, Salt Lake City
St. Mark's Hospital, Salt Lake City
Salt Lake County Hospital, Salt Lake City
Thomas D. Dee Memorial Hospital, Ogden

50 to 100 beds

Utah-Idaho Hospital, Logan

VERMONT

100 or more beds

Mary Fletcher Hospital, Burlington

50 to 100 beds

Fanny Allen Hospital, Winooski
Heaton Hospital, Montpelier
Rutland Hospital, Rutland
*St. Albans Hospital, St. Albans

35 to 50 beds

*Brattleboro Memorial Hospital, Brattleboro

VIRGINIA

100 or more beds

Chesapeake and Ohio Hospital, Clifton Forge
Hospital Division of Medical College of Virginia, Richmond
Norfolk Protestant Hospital, Norfolk
Retreat for the Sick, Richmond
St. Vincent's Hospital, Norfolk
Stuart Circle Hospital, Richmond
University of Virginia Hospital, Charlottesville

50 to 100 beds

*Dixie Hospital and Hampton Training School for Nurses, Newport News
Elizabeth Buxton Hospital, Newport News
George Ben Johnston Memorial Hospital, Abingdon
Grace Hospital, Richmond
Jefferson Hospital, Roanoke
Johnston-Willis Sanitarium, Richmond
King's Daughters Hospital, Staunton
*King's Daughters Hospital, Portsmouth
Lake View Hospital, Suffolk
Lewis Gale Hospital, Roanoke
*Lynchburg Hospital and City Home, Lynchburg
*Mt. Sinai Hospital, Norfolk
Parrish Memorial Hospital, Portsmouth
*Riverside Hospital, Newport News

Roanoke Hospital, Roanoke
St. Elizabeth's Hospital, Richmond
St. Luke's Hospital, Richmond
Sarah Leigh Hospital, Norfolk
*Sheltering Arms Free Hospital, Richmond
Shenandoah Hospital, Roanoke
Tucker Sanitarium, Richmond
Winchester Memorial Hospital, Winchester

WASHINGTON

100 or more beds

Children's Orthopedic Hospital, Seattle
Columbus Sanitarium, Seattle
King County Hospital, Seattle
Maria Beard Deaconess Hospital, Spokane
*Northern Pacific Hospital, Tacoma
Providence Hospital, Seattle
Sacred Heart Hospital, Spokane
St. Elizabeth's Hospital, Yakima
St. Joseph's Hospital, Tacoma
St. Luke's Hospital, Spokane
St. Mary's Hospital, Walla Walla
Seattle City Hospital, Seattle
Seattle General Hospital, Seattle
Swedish Hospital, Seattle
Tacoma General Hospital, Tacoma
Virginia Mason Hospital, Seattle

50 to 100 beds

*Everett General Hospital, Everett
Minor Private Hospital, Seattle
*Providence Hospital, Everett
*St. Anthony's Hospital, Wenatchee
*St. Joseph's Hospital, Aberdeen
St. Joseph's Hospital, Bellingham
St. Luke's Hospital, Bellingham
St. Luke's Hospital, Seattle
Walla Walla Sanitarium, College Place

WEST VIRGINIA

100 or more beds

Charleston General Hospital, Charleston
Kessler Hatfield Hospital, Huntington
Ohio Valley Hospital, Wheeling
St. Mary's Hospital, Clarksburg
Welch Hospital, No. 1, Welch
Wheeling Hospital, Wheeling

50 to 100 beds

Beckley Hospital, Beckley
Bluefield Sanitarium, Bluefield
*Chesapeake and Ohio R. R. Hospital, Huntington
Coal Valley Hospital, Montgomery
*Cook Hospital, Fairmont
Davis Memorial Hospital, Elkins
Fairmont Hospital, Fairmont
Guthrie Hospital, Huntington
Kings Daughters Hospital, Beckley
*Kings Daughters Hospital, Martinsburg
McKendree Hospital, No. 2, McKendree
*St. Joseph's Hospital, Parkersburg
St. Luke's Hospital, Bluefield

WISCONSIN

100 or more beds

Columbia Hospital, Milwaukee
Holy Family Hospital, Manitowoc
LaCrosse Lutheran Hospital, LaCrosse
Luthern Hospital, Eau Claire
Madison General Hospital, Madison
Marquette University Hospital, Milwaukee
Mercy Hospital, Janesville
Milwaukee Children's Hospital, Milwaukee
Milwaukee County Hospital, Milwaukee
Milwaukee Hospital, Milwaukee
Mt. Sinai Hospital, Milwaukee
St. Anges Hospital, Fond du Lac
St. Elizabeth's Hospital, Appleton
St. Francis Hospital, LaCrosse
St. Joseph's Hospital, Marshfield
St. Joseph's Hospital, Milwaukee
*St. Mary's Hospital, Green Bay
St. Mary's and Mercy Hospitals, Oshkosh
St. Mary's Hospital, Milwaukee
St. Mary's Hospital, Superior
*St. Mary's Hospital, Wausau
Wisconsin State General Hospital, Madison

50 to 100 beds

Evangelical Deaconess Hospital, Milwaukee
Grandview Hospital, LaCrosse
*Hanover Hospital, Milwaukee
*LaCrosse Public Hospital, LaCrosse
Milwaukee Infant's Home and Hospital, Milwaukee
Milwaukee Maternity Hospital, Milwaukee
*St. Catherine's Hospital, Kenosha
St. Joseph's Hospital, Dodgeville
*St. Luke's Hospital, Racine
St. Mary's Hospital, Madison
St. Mary's Hospital, Racine

35 to 50 beds

Methodist Hospital, Madison

WYOMING

50 to 100 beds

Casper Private Hospital, Casper
*Natrona County Hospital, Casper
Wheatland Hospital, Wheatland

CANADA

ALBERTA

100 or more beds

Edmonton General Hospital, Edmonton
General Hospital, Calgary
Holy Cross Hospital, Calgary
Medicine Hat Hospital, Medicine Hat
Misericordia Hospital, Edmonton
Royal Alexandra Hospital, Edmonton
University of Alberta Hospital, Edmonton

50 to 100 beds

Brett Hospital, Banff
*Galt Hospital, Lethbridge
Lamont Public Hospital, Lamont
Municipal Hospital, Drumheller

BRITISH COLUMBIA

100 or more beds

Provincial Royal Jubilee Hospital, Victoria
Royal Columbian Hospital, New Westminster
Royal Inland Hospital, Kamloops
St. Eugene Hospital, Cranbrook

St. Joseph's Hospital, Victoria
St. Paul's Hospital, Vancouver
Vancouver General Hospital, Vancouver

50 to 100 beds

Queen Victoria Hospital, Revelstoke
*St. Mary's Hospital, New Westminster
*Vernon Jubliee Hospital, Vernon

MANITOBA

100 or more beds

Brandon General Hospital, Brandon
Children's Hospital, Winnipeg
Grace Hospital, Winnipeg
King Edward Hospital, Winnipeg
King George Hospital, Winnipeg
Misericordia Hospital, Winnipeg
St. Boniface Hospital, St. Boniface
*Victoria Hospital, Winnipeg
Winnipeg General Hospital, Winnipeg

NEW BRUNSWICK

100 or more beds

General Public Hospital, St. John
St. John County Hospital, East St. John

50 to 100 beds

Chipman Memorial Hospital, St. Stephen
Hotel Dieu, Campbellton
Hotel Dieu, Chatham
Miramichi Hospital, New Castle
Moncton Hospital, Moncton
St. John's Infirmary, St. John
Soldiers Memorial Hospital, Campbellton
Victoria Public Hospital, Frederickton

NOVA SCOTIA

100 or more beds

St. Joseph's Hospital, Glace Bay
Salvation Army Hospital, Halifax
Victoria Hospital, Halifax

50 to 100 beds

*Aberdeen Hospital, New Glasgow
Children's Hospital, Halifax
*General Hospital, Glace Bay
Grace Maternity Hospital, Halifax
*Halifax Infirmary, Halifax
Highland View Hospital, Amherst
St. Martha's Hospital, Antigonishe
Sydney City Hospital, Sydney
*Yarmouth Hospital, Yarmouth

ONTARIO

100 or more beds

Brantford General Hospital, Brantford
General Hospital, Toronto
Grace Hospital, Toronto
Hamilton General Hospital, Hamilton
Hotel Dieu, Kingston
Hotel Dieu, Windsor
General Hospital, Kingston
*McKellar General Hospital, Ft. William
Ottawa General Hospital, Ottawa
Protestant General Hospital, Ottawa
St. Joseph's Hospital, Hamilton
St. Joseph's Hospital, London
St. Joseph's Hospital, Port Arthur
St. Joseph's Hospital, Sudbury
St. Luke's General Hospital, Ottawa
St. Michael's Hospital, Toronto
Sick Children's Hospital, Toronto
Western Hospital, Toronto
Victoria Hospital, London
Wellesley Hospital, Toronto

50 to 100 beds

*General Hospital, Belleville
General Hospital, Sault Ste. Marie
*Niagara Falls Memorial Hospital, Niagara Falls
Nicholls Hospital, Peterboro
Oshawa General Hospital, Oshawa
Owen Sound General and Marine Hospital, Owen Sound
Public Hospital, Smith Falls
St. Francis Hospital, Smith Falls
St. Joseph's Hospital, Peterboro
*Welland County Hospital, Welland
Women's College Hospital, Toronto

PRINCE EDWARD ISLAND

50 to 100 beds

Charlottetown Hospital, Charlottetown
Prince Edward Island Hospital, Charlottetown
Princes County Hospital, Sumerside

QUEBEC

100 or more beds

Children's Memorial Hospital, Montreal
De La Misericordia Hospital, Montreal
General St. Vincent Hospital, Sherbrooke
Hotel Dieu, Montreal
Jeffery Hale's Hospital, Quebec
Montreal General Hospital, Montreal
Notre Dame Hospital, Montreal
Royal Victoria Hospital, Montreal
Sainte Justine Pour Les Enfants, Montreal
Western Hospital, Montreal

50 to 100 beds

*Homeopathic Hospital, Montreal
Montreal Foundling and Baby Hospital, Montreal
Montreal Maternity Hospital, Montreal
*St. Francois d' Assise, Quebec
*Sherbrooke Hospital, Sherbrooke

SASKATCHEWAN

100 or more beds

Grey Nun's Hospital, Regina
*Moose Jaw General Hospital, Moose Jaw
St. Paul's Hospital, Saskatoon
Saskatoon City Hospital, Saskatoon

50 to 100 beds

Holy Family Hospital, Prince Albert
Notre Dame Hospital, North Battleford
Providence Hospital, Moose Jaw
Victoria Hospital, Prince Albert

HAWAII

Queens Hospital, Honolulu

NEW ZEALAND

Dunedin Hospital, Dunedin

NATIONAL HOMES FOR DISABLED VOLUNTEER SOLDIERS

National Military Home, Sawtelle, California
National Sanitarium, Hot Springs, South Dakota
National Sanitarium, Johnson City, Tennessee
National Military Home, Hampton, Virginia
National Military Home, Danville, Illinois
National Sanitarium, Marion, Indiana
National Military Home, Dayton, Ohio
National Military Home, Milwaukee, Wisconsin
National Military Home, Togus, Maine
National Military Home, Leavenworth, Kansas

MARINE HOSPITALS OF THE UNITED STATES PUBLIC HEALTH SERVICE

Marine Hospital, No. 1, Baltimore, Maryland
Marine Hospital, No. 10, Key West, Florida
Marine Hospital, No. 11, Louisville, Kentucky
Marine Hospital, No. 15, Pittsburgh, Pennsylvania
Marine Hospital, No. 20, Savannah, Georgia
Marine Hospital, No. 21, Stapleton, New York
Marine Hospital, No. 43, Ellis Island, New York
Marine Hospital, No. 66, Carville, Louisville
Marine Hospital, No. 70, New York, New York
Marine Hospital, No. 12, Memphis, Tennessee
Marine Hospital, No. 13, Mobile, Alabama
Marine Hospital, No. 14, New Orleans, Louisiana
Marine Hospital, No. 18, St. Louis, Missouri
Marine Hospital, No. 82, Norfolk, Virginia
Marine Hospital, No. 5, Chicago, Illinois
Marine Hospital, No. 17, Pt. Townsend, Washington